THE

POPULAR SCIENCE MONTHLY.

JULY, 1875.

ANENT ANTS.

By E. R. LELAND.

SINCE the earliest recorded observations of insect-life, the ant has been a subject of especial comment and wonderment. Found throughout the range of both temperate and the torrid zones, it is in the tropics that the most interesting species abound, and where their vast numbers and their industry and fearless pertinacity make them a veritable scourge.

Many confused, not to say fabulous, statements regarding them have been published in books of travels, and copied in natural history works; but enough has been recorded concerning them, which has the warrant of recent and high authority, to justify the views popularly held as to their intelligence and sagacity.

Mr. Bates, in "The Naturalist on the Amazon," devotes considerable space to them, and, in the descriptions following, very free use is made of his delightful book, and most of the illustrations are borrowed from that source.

One of the chief peculiarities of the ants is their social relations. Assembling in countless multitudes, they are divided into different classes, each with a special order of duties to fulfill, but all working harmoniously for a definite end — the perpetuation of the species. Their communities consist of males, females, and neuters; with generally two and sometimes three distinct orders or castes of the latter. Upon them devolves all the labor, the divisions being known as the worker-minors and the worker-majors, the brunt of the work falling upon the first, while the function of the worker-major, though not definitely understood, seems to be that of a superintendent or a soldier, or perhaps a combination of the two.

One of the most interesting of the American species is the saüba, or leaf-cutting ant (*Œcodoma cephalotes*). The workers of this species are of three orders, and vary in size from two to seven lines. Some idea of them may be obtained from the accompanying woodcut.

The true working-class of a colony is formed by the small-sized order of workers (1, Fig. 1). The two other kinds have enormously-swollen heads; in one of these the head is highly polished (2); in the other (3) it is opaque and hairy. The worker-minors vary greatly in size, some being double the bulk of others. The entire body is of solid consistence, and of a pale, reddish-brown color. The thorax, or middle segment, is armed with three pairs of sharp spines; the head also has a pair of similar spines proceeding from the cheeks behind.

FIG. 1.—SAÜBA, OR LEAF-CUTTING ANT.—1, Worker-minor; 2, Worker-major; 3, Subterranean Worker.

Their domes or outworks are very extensive, some of them being forty yards in circumference, but not more than two feet high. The entrances are small and numerous; in the large hillocks a great amount of excavation is required to get at the main galleries; the minor entrances converge at a few feet below the ground to one broad, elaborately-worked gallery or mine four or five inches in diameter. These underground abodes are very extensive. The Rev. Hamlet Clark relates that the saüba of Rio de Janeiro has excavated a tunnel under the bed of the river Parahyba, at a place where it is as broad as the Thames at London Bridge. At the Magoary Rice-Mills, near Pará, these ants once pierced the embankment of a large reservoir; the great body of water which it contained escaping before the damage could be repaired. One other fact is told of these ants, which shows the herculean nature of their labors. Their lives are dependent upon access to water, and they always choose places where it is to be obtained by digging wells. One case is related where a well was dug for domestic purposes, and water found at a depth of thirty feet; to do this, an ant-well was followed which was twelve inches in diameter.

The habit in this ant of clipping and carrying away immense quantities of leaves has long been recorded. When employed in this work, their processions look like a multitude of animated leaves on the march. They mount the trees in swarms. Each one places itself on the surface of a leaf, and cuts with its sharp, scissor-like jaws a nearly semi-

circular incision on the upper side; it then takes the edge between its jaws, and, by a sharp jerk, detaches the piece which is about the size of a dime. Sometimes they let the leaf drop to the ground, where a little heap accumulates, until carried off by another relay of workers; but generally each marches off with the piece it has operated upon, and, as all take the same road to their colony, the path they follow soon becomes smooth and bare, looking like the impression of a cart-wheel through the herbage. The heavily-laden workers troop up and cast their burdens on the hillock; another relay of laborers place the leaves in position, covering them with a layer of earthy granules, which are brought up one by one from the soil beneath. It has not been shown satisfactorily to what use the leaves are put. It was formerly supposed that they were consumed as food. Mr. Bates's investigations convinced him that the leaves were used to thatch the domes which cover the entrances to the subterranean dwellings, thereby protecting from the deluging rains the young broods in the nests beneath. Mr. Belt, however, who observed the leaf-cutting ants in Central America, and gives a full and interesting account of them in his "Naturalist in Nicaragua," arrives at the conclusion that the leaves which they gather in such enormous quantities are used to form beds for the growth of a minute fungus, on which they and their young live. Fritz Müller, writing from Brazil (*Nature*, vol. x., p. 102), says that he has always held this view, and that an examination of their stomachs under the microscope confirms it.

This ant is so abundant in some districts that agriculture is almost impossible, and wherever it exists it is a terrible pest. It is also troublesome to the inhabitants from its habit of plundering the stores of provisions in houses at night, for it is even more active by night than in the daytime.

The principal part of the visible work is done by the small-heads (1, Fig. 1), while those which have massive heads, the worker-majors (2), are generally observed to be simply walking about. They are not, in this species, soldiers, for they never fight. The function of superintendence would seem superfluous in a community where all work with precision. They cannot, however, be entirely useless to the community, for the sustenance of an idle class of such bulky individuals would be too heavy a charge for the species to sustain. Prof. Sennichrast, who studied some of the species of *Œcodoma* in Mexico, is of the opinion that their special *rôle*, if they have one, is borne in the excavation of the nest, and in tunneling the galleries, labors which require superior strength and better implements.

The third order of workers is the most curious. If the main shaft of a mine be probed, a small number of colossal fellows (3, Fig. 1) will slowly begin to make their way up the smooth sides of the mine. In the middle of the forehead is a trim *ocellus*, or simple eye, of quite different structure from the ordinary compound eye on the sides of the

head. This frontal eye is totally wanting in the other workers, and is not known in any other kind of ant. Their special functions are unknown. None of this species are pugnacious.

The work of reproduction begins with the rainy season. The union probably takes place in the night, for in the morning the neighborhood of the nest will be strewed with the females, and the dead bodies of the males, the former already fertile, from whom the workers make it their duty to tear away the wings. The true females are incapable of attending to the wants of their offspring; and it is on the poor, sterile workers, who are denied all the other pleasures of maternity, that the care devolves. The successful *début* of the winged males and females depends likewise on the workers. Great activity reigns in an ants'-nest on the exodus of the winged individuals. The workers clear the roads of exit, and show the most lively interest in their departure, although it is highly improbable that any of them will return to the same colony. They are of large size, the female measuring two and a quarter inches in expanse of wing; the male is not much more than half the size. They swarm in vast numbers, but are so eagerly preyed upon by insectivorous animals that but few of the impregnated females escape the slaughter to found new colonies. An immense amount of labor would be saved to the ants, if, instead of raising annually myriads of winged males and females to perish, they raised only a few wingless males and females, which, free from danger, might remain in their native nests; and, as Fritz Müller says, he who does not admit the paramount importance of intercrossing must of course wonder why the latter manner of reproduction has not long since taken the place, through natural selection, of the production of winged males and females. But the wingless individuals would of course have to pair always with their near relatives, while by swarming a chance is given for the intercrossing of individuals not nearly related.

Fig. 2.—Saüba Ant, Female.

Resembling the saüba, in being vegetable-feeders, are the harvesting-ants (*Atta structor*, *A. barbara*, *Pheidole megacephala*, etc.). It has been a fashion among naturalists to set down as pure invention the accounts by classical writers of the accumulation of cereals by ants for winter consumption, and to assume that the Biblical injunction to

study the ways of her "who, having no guide, overseer, or ruler, provideth her meat in the summer, and gathereth her food in the harvests," was a figure drawn from careless observation; that ants, being carnivorous insects, would not eat dry, hard grains of wheat or barley, the idea that they would do so having arisen from mistaking the whitish cocoons which inclose the pupæ for grains of wheat, to which they bear a resemblance. But Mr. Traherne Moggridge has recently, by careful observation in the south of Europe, confirmed in many of their minutest details the accounts given by ancient writers, and shown that, in treating these accounts with contempt, it is the modern authors who have been guilty of forming hasty conclusions from insufficient data.

The ants were described as ascending the stalks of cereals and gnawing off the grains, while others below detached the seed from the chaff and carried it home; as gnawing off the radicle to prevent germination, and spreading their stores in the sun to dry after wet weather. These statements Mr. Moggridge has verified, supplementing them by discovering the granaries in which they are stored, sometimes excavated in solid rock. He has seen them in the act of collecting seeds, and has traced seeds to the granaries; he has seen them bring out the grains to dry after a rain, and nibble off the radicle from those which were germinating; lastly, he has seen them feed on the seeds so collected. A curious point is, that the collections of seeds, although stored in damp situations, very rarely germinate; yet nothing has been done to deprive them of vitality, for, on being sown, they grow vigorously. Their depredations are of such extent as must cause serious loss to cultivators.

Texas and Northern Mexico furnish a remarkable species in the honey-making ants (*Myrmecocystus Mexicanus*). The workers of their communities are divided into three classes: 1. Yellow workers, nurses and feeders; 2. Yellow workers, honey-makers; 3. Black workers, guards and purveyors.

The site chosen for their nest is usually some sandy soil in the neighborhood of shrubs and flowers, the space occupied being four or five feet square. The black workers surround the nests as guards, and are always in a state of great activity. They form two lines of defense, moving different ways, their march always being along three sides of a square; one column moving from the southeast to the southwest corners of the fortification, while the other proceeds in the opposite direction. Most of the nests lie open to the south; the east, west, and northern sides, being surrounded by the soldiers. In case of an enemy approaching, a number of guards sally forth to meet the intruder. Spiders, wasps, beetles, and other insects are, if they come too near the hive, savagely attacked, and the dead bodies speedily removed from the neighborhood, the soldiers at once resuming their places in the line.

Their object in destroying other insects is protection of the encampment, and not the obtaining of food. While one section of the black workers is thus engaged, a more numerous division will be found employed in entering the quadrangle by a diagonal line, bearing northeast, and carrying flowers and fragments of aromatic leaves, which they deposit in the centre of the square.

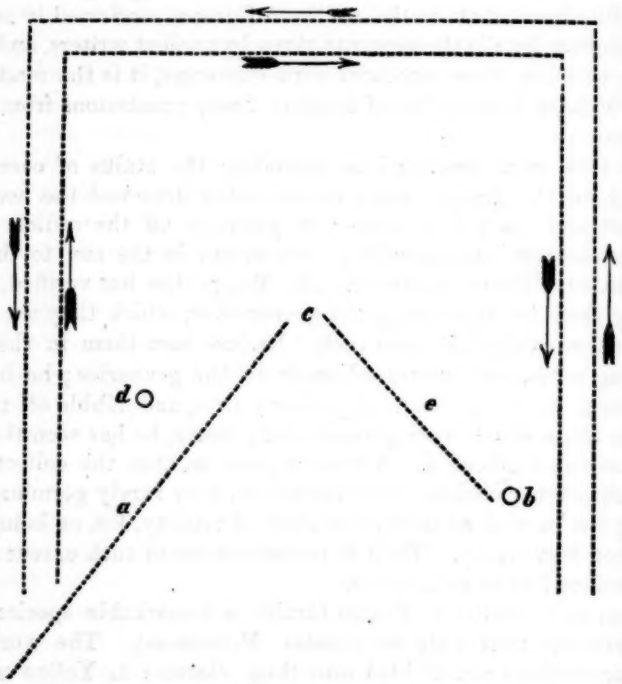

FIG. 3.—ENCAMPMENT OF THE HONEY-MAKING ANT (*Myrmecocystus Mexicanus*).

The line *a* of the sketch shows the path of this latter section, the mound of flowers and leaves being at *c*. This line leads to the shrubs, upon which another division of the black workers is settled, engaged in cutting off the leaves and petals to be conveyed to the nest. On the west side of the encampment is a hole marked *d*, leading to the interior of the nest. It is probably intended for the introduction of air, as, in case of any individuals carrying their loads into it, they immediately emerge and carry them to the common heap, as if conscious of having made a mistake. A smaller hole, near the southeast corner of the square, is the only other means by which the interior can be reached; and down this aperture, *b*, the flowers gathered by the black workers are carried along the line *e* from the heap in the centre of the square, by a number of the small yellow workers, who seem adapted for the gentler office of nurses for the colony within. No black ant is

ever seen on the line *e*, and no yellow one ever approaches the line *a*, each keeping his own station, and following his given line of duty with a steadfastness which is remarkable.

When the course of the galleries is traced from the entrances, a small excavation is reached, across which is stretched, in the form of a spider's web, a net-work of squares about one-quarter inch across, the ends of the web being fastened firmly to the earth of the sides of the cell. In each one of the squares, supported by the web, sits one of the honey-making workers—prisoners, for locomotion is impossible, the distended abdomen which constitutes the honey-bag being at least twenty times as large as the rest of the body. The workers provide them a constant supply of flowers and pollen, which, by a process analogous to that of the bee, they convert into honey. Whether the honey-makers are themselves used as food, or excrete their saccharine fluid, and then proceed to distill more, is not known. Indeed, that the remainder of the inhabitants feed on the supply thus obtained in any manner, although surmised, has not been established, very little being known of the economy of these creatures.

The honey is much sought after by the Mexicans, who not only use it as a delicate article of food, but ascribe to it great healing properties.

The worst insect pest of tropical America is the terrible fire-ant (*Myrmica sævissima*), whose sting is likened to the puncture of a red-hot needle. It is found only on sandy soils in open places, and seems to thrive most near houses and in weedy villages. Towns are sometimes deserted on account of this little tormentor. It is a small species, of a shining red color, not greatly differing from the common red stinging-ant of our own country, except that the pain and irritation caused by its sting are much greater. Where it abounds, the whole soil is undermined by it; the ground is perforated with the entrances to their subterranean galleries, and a little sandy dome occurs here and there where the insects bring their young to receive warmth near the surface. Homes are overrun with them; they dispute every fragment of food with the inhabitants, and destroy clothing for the sake of the starch. All eatables have to be suspended in baskets from the rafters, and the cords well soaked with copaiba-balsam, which is the only means known to prevent them from climbing. They seem to attack persons out of sheer malice. The legs of tables, chairs, and stools, and the cords of hammocks, have to be smeared in the same way.

Belonging to a totally different group are the *Ecitons*, or foraging-ants; they are carnivorous, and hunt in vast armies, exciting terror wherever they go, resembling in their habits the often-described drivers of tropical Africa, though belonging to quite another sub-group of the ant tribe. They are composed, besides males and females, of two classes of workers—a large-headed and a small-headed

class; the large-heads have, in some species, greatly-lengthened jaws; the small-heads have jaws always of the ordinary shape, but the two classes are not sharply defined in structure and function, except in two species. In these the jaws of the worker-majors are so monstrously lengthened that they are incapacitated for taking part in the labors of the worker-minors, and act as soldiers. The peculiar feature in the habits of the genus *Eciton* is their hunting for prey in regular bodies or armies. It is this which chiefly distinguishes them from the genus *Myrmica*, the common red stinging-ant of the temperate zone, whose habit is to search for food in the usual irregular manner. All the *Ecitons* hunt in large organized bodies; but almost every species has its own special manner of hunting.

Eciton Legionis.—In this species there is no division in classes among its workers, although the difference in size is very great. It lives in open places, and its movements are easy to be observed; its sting and bite are not very formidable. The armies consist of thousands of individuals, and move in rather broad columns. They are quick to break line on being disturbed, and attack hurriedly and furiously any intruding object. Their activity seems to be chiefly directed to plundering the nests of a large defenseless ant of another genus (*Formica*).

Eciton Drepanophara.—This, one of the commonest species of foraging-ants, confines its ravages to the thickest part of the forest. When a pedestrian falls in with one of their trains, the first signal given him is a twittering and restless movement of small flocks of plain-colored birds (ant-thrushes) in the jungle. If this be disregarded, and he advances a few steps farther, he is sure to fall into trouble, and find himself suddenly attacked by numbers of the ferocious little creatures. They swarm up his legs with incredible rapidity, each one driving his pincer-like jaws into his skin, and, with the purchase thus obtained, doubling its tail and stinging with all its might. There is no course left but to run for it. The tenacious insects then have to be plucked off, one by one, a task which is generally not accomplished without pulling them in twain, and leaving heads and jaws sticking in the wounds.

The errand of the vast ant-armies is plunder. Wherever they move, the whole animal world is set in commotion, and every creature tries to get out of their way. It is especially wingless insects that have cause to fear, such as heavy-bodied spiders, maggots, caterpillars, larvæ of cockroaches, etc., all of which live under fallen leaves, or in decaying wood. The main column, from four to six deep, moves forward in a given direction, clearing the ground of all animal matter, dead or alive, and throwing out here and there a thinner column to forage for a short time on the flanks of the main army. If some rich place be encountered, for example, a mass of rotten wood abounding in insect-larvæ, a delay takes place, and a very strong force is concen-

trated upon it. The excited creatures search every cranny, and tear in pieces all the grubs they bring to light. They attack wasps'-nests, when built on low shrubs, gnawing away the paper covering to get at the larvæ, pupæ, and newly-hatched wasps, and cut every thing to tatters, regardless of the infuriated owners which are flying about them.

Fig. 4.—Foraging-Ants (*Eciton drepanophora*).

The life of the *Ecitons* is not all work, however; they seem frequently to be employed in a way that looks like recreation. This always takes place in a sunny nook. The main column of the army and the branch columns are in their ordinary relative positions; but, instead of pressing forward eagerly and plundering right and left, they seem to be smitten with a sudden fit of laziness. Some walk slowly about; others brush their antennæ with their fore-feet; but the drollest sight is their cleaning one another. Here and there an ant may be seen, stretching forth first one leg and then another, to be brushed and washed by one or more of its comrades, who perform the task by passing the limb between the jaws and the tongue, finishing by giving the antennæ a friendly wipe. It is a curious spectacle, and well calculated to increase one's amazement at the similarity between the actions of ants and the acts of rational beings—a similarity which must have been brought about by different processes of development of the primary qualities of mind. The action of these ants looks like simple indulgence in idle amusement. Have these little creatures, then, an excess of energy, and do they expend it in mere sportiveness, like young kittens, or in idle whims, like rational beings?

Eciton Prædator.—This species differs from other *Ecitons*, chiefly from its habit of hunting, not in columns, but in dense phalanxes consisting of myriads of individuals. A phalanx, when passing over smooth ground, occupies a space from four to six yards square. Nothing in insect-movements is more striking than this rapid march of these large compact bodies.

Blind Ecitons.—None of the foregoing kinds have eyes of the

faceted or compound structure, such as are usual in insects, and which ordinary ants (*Formica*) are furnished with; but all are provided with organs of vision, composed each of a single lens. Connecting them with the utterly blind species of the genus, is a very stout-limbed *Eciton*, the *E. crassicornis*, whose eyes are sunk in deep sockets. This ant goes on foraging expeditions like the rest of its tribe, but it avoids the light, always moving in concealment under leaves and fallen branches. When its columns have to cross a cleared space, the ants construct a temporary covered way with granules of earth, arched over, and holding together mechanically; under this the procession passes in secret, the indefatigable creatures repairing their arcade as fast as breaches are made in it.

Next in order comes the *E. vastator*, which has no eyes, though the collapsed sockets are plainly visible; and, lastly, the *E. erratica*, in which both sockets and eyes have disappeared, leaving only a faint ring to mark the place. The armies of *E. vastator* and *E. erratica* move wholly under covered roads, constructing them rapidly as they advance. The column of foragers pushes forward, step by step, under the protection of these covered ways, and, on reaching a rotten log, or other promising hunting-ground, pour into the crevices in search of booty. The grains of earth for their arcades are taken from the soil over which the column is passing, and are fitted together without cement.

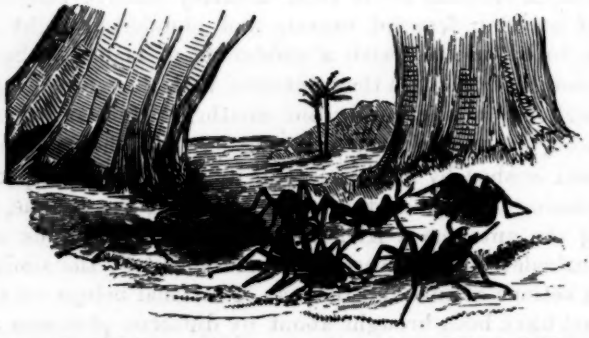

FIG. 5.—FORAGING-ANTS (*Eciton erratica*), constructing a Covered Road—Soldiers sallying out on being disturbed.

Working in numbers, they build up simultaneously the sides of their convex arcades, and contrive in a surprising manner to approximate them and fit in the key-stone without letting the loose, uncemented structure fall to pieces. There is a very clear division of labor between the two classes of neuters in these blind species. When a breach is made in one of their covered ways, all the ants underneath are set in commotion, but the worker-minors remain behind to repair the damage, while the large-heads issue forth in a most menacing manner, rearing their heads, and snapping their jaws with an expres-

sion of fiercest rage and defiance. Pitched battles sometimes occur between different pugnacious species, and classical writers have deemed them worthy to be recorded. Kirby and Spence relate that "Æneas Sylvius, after giving a circumstantial account of one contested with great obstinacy by a large and a small species, adds that 'this action was fought in the Pontificate of Eugenius IV.'" Thoreau gives a graphic description—in his whimsical style of exalting small things and emphasizing the trifling difference that there is between big and little actors and events in Nature—of a similar engagement that took place near his hut "in the presidency of Polk, five years before the passage of Webster's Fugitive Slave Bill" ("Walden," p. 346).

Whether such an enactment obtains in any of the ant nations is unknown, but that certain of them possess the extraordinary instinct of capturing the pupæ of other species and bringing them up as slaves, is a well-authenticated fact. They are made captive while still in the cocoon, and on emerging become the auxiliary workers and friends of their captors, as though such was their natural destiny.

But no fanciful exaggeration is needed to impress us with the degree of forethought, methodical industry, and dauntless courage, the engineering and mechanical skill, the reasoning and perceptive powers and general sagacity which the ant displays.

If space permitted, numerous illustrative citations could be given. A member of the Natural History Society describes a tubular bridge, half an inch in diameter, and spanning a chasm twelve inches across. A correspondent of Mr. Darwin's, Mr. Joseph D. Hague, a geologist of California, submits what seems to be satisfactory evidence that they realize danger from seeing the corpses of their fellows, an inference drawn by no other invertebrate, if indeed it be by the higher animals.

They keep domestic animals. The aphides, or plant-lice, excrete a peculiar sweet fluid which the ant obtains by caressing the abdomen of the aphis with its antennæ. Ordinarily they seek the aphides upon plants, but that they also keep them in their nests much as man keeps cows, is an opinion which receives the sanction of eminent naturalists, among them Sir John Lubbock, who further says: "Ants also keep a variety of beetles and other insects in their nests. That they have some reason for this seems clear, because they readily attack any unwelcome intruder; but what that reason is we do not yet know. If these insects are domesticated by the ants, then we must admit that the ants possess more domestic animals than we do."

Indeed, their whole social economy is of a complex order. Nowhere is the division of labor—which in mankind always marks a high state of civilization—so rigid, being carried to the extreme of a physical modification of great numbers of the community for the better fulfillment of their duties. Their undeveloped sterile females may serve to warn—or to encourage—those members of the *Anthropida*

who are so anxious to subordinate, if not wholly lay down, the gentle functions of maternity in order that they may engage in the sterner work of the world!

When, marking their size, we consider the mighty character of the works which they complete; when we reflect upon the infinitesimal ganglion which is the seat of the intelligence they display, we may well be filled with surprise, and almost wonder if man, or any other order of the vertebrata, is destined to remain forever the higher animal!

THE FIRST AND THE LAST CATASTROPHE.

By W. KINGDON CLIFFORD,
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I PROPOSE in this lecture to consider speculations of quite recent days about the beginning and the end of the world. The world is a very interesting thing, and I suppose that from the earliest times that men began to form any coherent idea of it at all, they began to guess in some way or other how it was that it all began, and how it was all going to end. But there is one peculiarity about these speculations which I wish now to consider, that makes them quite different from the early guesses of which we read in many ancient books. These modern speculations are attempts to find out how things began, and how they are to end, by consideration of the way in which they are going on now. And it is just that character of these speculations that gives them their interest for you and for me; for we have only to consider these questions from the scientific point of view. By the scientific point of view, I mean one which attempts to apply past experience to new circumstances according to an observed order of Nature. So that we shall only consider the way in which things began, and the way in which they are to end, in so far as we seem able to draw inferences about those questions from facts which we know about the way in which things are going on now. And, in fact, the great interest of the subject to me lies in the amount of illustration which it offers of the degree of knowledge which we have now attained of the way in which the universe is going on.

The first of these speculations is one set forth by Prof. Clerk Maxwell, in a lecture on "Molecules," delivered before the British Association at Bradford. By a coincidence, which to me is a happy one, at this moment Prof. Maxwell is lecturing to the Chemical Society of London upon the evidences of the molecular constitution of matter. Now, this argument of his, which he put before the British Association at Bradford, depends entirely upon the modern theory of the molecular constitution of matter. I think this the more important,

because a great number of people appear to have been led to the conclusion that this theory is very similar to the guesses which we find in ancient writers—Democritus and Lucretius. It so happens that these ancient writers did hold a view of the constitution of things which in many striking respects agrees with the view which we hold in modern times. This parallelism has been brought recently before the public by Prof. Tyndall in his excellent address at Belfast. And it is perhaps on account of the parallelism, which he pointed out at that place, between the theories held among the ancients and the theory now held among the moderns, that many people who are acquainted with classic literature have thought that a knowledge of the views of Democritus and Lucretius would enable them to understand and criticise the modern theory of matter. That, however, is a mistake. The difference between the two is mainly this: the atomic theory of Democritus was a guess, and no more than a guess. Every body around him was guessing about the origin of things, and they guessed in a great number of ways; but he happened to make a guess which was more near the right thing than any of the others. This view was right in its main hypothesis, that all things are made up of elementary parts, and that the different properties of different things depend rather upon difference of arrangement than upon ultimate difference in the substance of which they are composed. Although this was contained in the atomic theory of Democritus, as expounded by Lucretius, yet it will be found by any one who examines further the consequences which are drawn from it, that it very soon diverges from the truth of things, as we might naturally expect it would. On the contrary, the view of the constitution of matter which is held by scientific men in the present day is not a guess at all.

In the first place, I will endeavor to explain what are the main points in this theory. First of all we must take the simplest form of matter, which turns out to be a gas—such, for example, as the air in this room. The belief of scientific men in the present day is that this air is not a continuous thing, that it does not fill the whole of the space in the room, but is made up of an enormous number of exceedingly small particles. There are two sorts of particles: one sort of particle is oxygen, and another sort of particle nitrogen. All the particles of oxygen are as near as possible alike in these two respects: first in weight, and secondly in certain peculiarities of mechanical structure. These small molecules are not at rest in the room, but are flying about in all directions with a mean velocity of seventeen miles a minute. They do not fly far in one direction; but any particular molecule, after going over an incredibly short distance—the measure of which has been made—meets another, not exactly plump, but a little on one side, so that they behave to one another somewhat in the same way as two people do who are dancing Sir Roger de Coverley; they join hands, swing round, and then fly away in different

directions. All these molecules are constantly changing the direction of each other's motion; they are flying about with very different velocities, although, as I have said, their mean velocity is about seventeen miles a minute. If the velocities were all marked off on a scale, they would be found distributed about the mean velocity just as shots are distributed about a mark. If a great many shots are fired at a target, the hits will be found thickest at the bull's-eye, and they will gradually diminish as we go away from that, according to a certain law, which is called the law of error. It was first stated clearly by Laplace; and it is one of the most remarkable consequences of this theory that the molecules of a gas have their velocities distributed among them precisely according to this law of error. In the case of a liquid, it is believed that the state of things is quite different. We said that in the gas these molecules are moved in straight lines, and that it is only during a small portion of their motion that they are deflected by other molecules; but in a liquid we may say that the molecules go about as if they were dancing the grand chain in the Lancers. Every molecule after parting company with one finds another, and so is constantly going about in a curved path, and never gets quite clear away from the sphere of action of the surrounding molecules. But, notwithstanding that, all molecules in a liquid are constantly changing their places, and it is for that reason that diffusion takes place in the liquid. Take a large tank of water and drop a little iodine into it, and you will find after a certain time all the water turned slightly blue. That is because all the iodine-molecules have changed like the others and spread themselves over the whole of the tank. Because, however, you cannot see that, except where you use different colors, you must not suppose that it does not take place where the colors are the same. In every liquid all the molecules are running about and continually changing and mixing themselves up in fresh forms. In the case of a solid quite a different thing takes place. In a solid every molecule has a place which it keeps; that is to say, it is not at rest any more than a molecule of a liquid or a gas, but it has a certain mean position which it is always vibrating about and keeping fairly near to, and it is kept from losing that position by the action of the surrounding molecules. These are the main points of the theory of the constitution of matter as at present believed. It differs from the theory of Democritus in this way. There is no doubt that in the first origin of it, when it was suggested as a whole, it was a guess of his.

In order to make out that your supposition is true, it is necessary to show, not merely that that particular supposition will explain the facts, but also that no other one will. Now, by the efforts of Clarges and Prof. Clerk Maxwell, the molecular theory of matter has been put in that other position, namely, instead now of saying, "Let us suppose that such and such things are true," and then deducing

from that supposition what these consequences ought to be, and showing that these consequences are just the facts which we observe—instead of doing that, I say, we make certain experiments, we show that certain facts are undoubtedly true, and from these facts we go back by a direct chain of logical reasoning, which there is no way of getting out of, to the statement that all matter is made up of separate pieces or molecules, and that in matter of a given kind, in oxygen, or in hydrogen, or in nitrogen, these molecules are of very nearly the same weight, and have certain mechanical properties which are common to all of them. In order to show you something of the kind of evidence for that statement, I must mention another theory which, as it seems to me, is in the same position, that is the doctrine of the luminiferous ether, or that wonderful substance which is distributed all over space, and which carries light and radiant heat. By means of certain experiments upon interference, we can show, not by any hypothesis, not by any guess at all, but by a pure interpretation of the experiment—we can show that in every ray of light there is some change or other, whatever it is, which is periodic in time and in place. By saying it is periodic in time, I mean that at a given point of the ray of light this change increases up to a certain point, then decreases, then increases in the other direction, and then decreases again. That is shown by experiments of interference; it is not a theory which will explain the facts, but it is a fact which is got out of observation. By saying that this phenomenon is periodic in space, I mean that, if at any given instant you could examine the ray of light, you would find that some change or disturbance, whatever it is, has taken place all along it in different degrees. It vanishes at certain points, and between these it increases gradually to a maximum on one side and the other alternately. That is to say, in traveling along a ray of light there is a certain change (which can be observed by experiments, by operating upon a ray of light with other rays of light), which goes through a periodic variation in amount. The height of the sea, as you know if you travel along it, goes through certain periodic changes; it increases and decreases, and increases and decreases again at definite intervals. And if you take the case of waves traveling over the sea, and place yourself at a given point, say you put a cork upon the surface, you will find that the cork will rise up and down, that is to say, there will be a change or displacement of the cork's position, which is periodic in time, which increases and decreases, then increases in the opposite direction, and decreases again. Now, this fact, which is established by experiment, and which is not a guess at all, the fact that light is a phenomenon, periodic in time and space, is what we call the wave-theory of light. The word theory here does not mean a guess; it means an organized account of the facts, such that from it you may deduce results, which may be applicable to future experiments, the like of which have not yet been

made. But we can see more than this. So far we say that light consists of waves, merely in the sense that it consists of some phenomenon or other which is periodic in time and in place; but we know that a ray of light is capable of doing work. Radiant heat, for example, striking on a body, will warm it and enable it to do work by expansion; therefore this periodic phenomenon which takes place in the ray of light is something or other which possesses mechanical energy, which is capable of doing work. We may make it, if you like, a mere matter of definition, and say, "Any change which possesses energy is a motion of matter;" and this is perhaps the most intelligible definition of matter that we can frame. In that sense, and in that sense only, it is a matter of demonstration, and not a matter of guess, that light consists of the periodic motion of matter which is between the luminous object and our eyes. But that something is not matter in the ordinary sense of the term, it is not made up of such molecules as gases and liquids and solids are made up of. This last statement, again, is no guess, but a proved fact.

There are people who ask, "Why is it necessary to suppose a luminiferous ether to be any thing else except molecules of matter in space, in order to carry light about?" The answer is a very simple one. In order that separate molecules may carry about a disturbance, it is necessary that they should travel at least as fast as the disturbance travels. Now we know, by means that I shall afterward come to, that the molecules of gas travel at a very ordinary rate, about twenty times as fast as a good train. But, on the contrary, we know by the most certain of all evidence, by five or six different means, that the velocity of light is 200,000 miles a second. By that very simple means we are able to tell that it is quite impossible for light to be carried by the molecules of ordinary matter, and that it wants something else that lies between those molecules to carry the light. Now, remembering the evidence which we have for the existence of this ether, let us consider another piece of evidence, let us now consider what evidence we have that the molecules of a gas are separate from one another and have something between them. We find out by experiment, again, that the different colors of light depend upon the various rapidity of these waves, depend upon the size and upon the length of the waves that travel through the ether, and that when we send light through glass or any transparent medium except a vacuum, the waves of different lengths travel with different velocities. That is the case with the sea; we find that long waves travel faster than small ones. In much the same way, when light comes out of a vacuum and impinges upon any transparent medium, say upon glass, we find that the rate of transmission of all the light is diminished, that it goes slower when it gets inside of a material body; and that this change is greater in the case of large waves than of small ones. The small waves correspond to blue light and the large waves correspond

to red light. The waves of red light are not made to travel so slowly as the waves of blue light, but, as in the case of waves traveling over the sea, when light moves in the interior of a transparent body the large waves travel quickest. Well, then, by using such a body as will separate out the different colors—a prism—we are able to affirm what are the constituents of the light which strikes upon it. The light that comes from the sun is made up of waves of various lengths; but making it pass through a prism we can separate it out into a spectrum, and in that way we find a band of light instead of a spot coming from the sun, and to every band in the spectrum corresponds a wave of a certain definite length and definite time in vibration. Now we come to a very singular phenomenon. If you take a gas such as chlorine and interpose it in the wave of that light, you will find that certain particular rays of the spectrum are absorbed, while others are not. Now, how is it that certain particular rates of vibration can be absorbed by this chlorine gas while others are not? That happens in this way, that the chlorine gas consists of a great number of very small structures, each of which is capable of vibrating internally. Each of these structures is complicated, and is capable of a change of relative position among its parts of a vibratory character. We know that molecules are capable of such vibrations, such internal vibrations, for this reason, that if we heat any solid body sufficiently it will in time give out light; that is to say, the molecules are got into such a state of vibration that they start the ether vibrating, and they start the ether vibrating at the same rate at which they vibrate themselves. So that what we learn from the absorption of certain particular rays of light by chlorine gas, is that the molecules of that gas are structures which have certain natural rates of vibration, precisely those rates of vibration which belong to the molecules naturally. If you sing a certain note to a string of a piano, that string if in tune will vibrate. If, therefore, a screen of such strings were put across a room, and you sang a note on one side, a person on the other side would hear the note very weakly or not at all, because it would be absorbed by the strings; but if you sang another note, not one to which the strings naturally vibrated, then it would pass through, and would not be eaten up by setting the strings vibrating. Now this question arises. Let us put the molecules aside for a moment. Suppose we do not know of their existence, and say, "Is this rate of vibration, which naturally belongs to the gas, a thing which belongs to it as a whole, or does it belong to separate parts of it?" You might suppose that it belongs to the gas as a whole. A jar of water, if you shake it, has a perfectly definite time in which it oscillates, and that is very easily measured. That time of oscillation belongs to the jar of water as a whole. It depends upon the weight of the water, and the shape of the jar. But now, by a very certain method, we know that the time of vibration which corresponds to a certain definite gas

does not belong to it as a whole, but belongs to the separate parts of it, for this reason: that if you squeeze the gas you do not alter the time of vibration. Let us suppose that we have a great number of fiddles in a room which are all in contact, and have strings accurately tuned to vibrate to certain notes. If you sang one of those notes all the fiddles would answer; but if you compress them you clearly put them all out of tune. They are all in contact, and they will not answer to the tune with the same precision as before. But if you have a room which is full of fiddles placed at a certain distance from one another, then if you bring them within shorter distances of one another, so that they still don't touch, they will not be put out of tune, they will answer exactly to the same note as before. We see, therefore, that since compression of a gas within certain limits does not alter the rate of vibration which belongs to it, that rate of vibration cannot belong to the body of gas as a whole, but it must belong to the individual parts of it. Now by such reasoning as this it seems to me that the modern theory of the constitution of matter is put upon a basis which is absolutely independent of hypothesis. The theory is simply an organized statement of the facts, a statement, that is, which is rather different from the experiments, being made out from them in just such a way as to be most convenient for finding out from them what will be the results of other experiments. That is all we mean at present by scientific theory.

Upon this theory Prof. Clerk Maxwell founded a certain argument in his lecture before the British Association at Bradford. It is a consequence of the molecular theory, as I said before, that all the molecules of a certain given substance, say oxygen, are as near as possible alike in two respects—first in weight, and secondly in their times of vibration. Now Prof. Clerk Maxwell's argument was this: He first of all said that the theory required us to believe not that these molecules were as near as may be alike, but that they were exactly alike in these two respects—at least the argument appeared to me to require that. Then he said all the oxygen we know of, whatever processes it has gone through—whether it is got out of the atmosphere, or out of some oxide of iron or carbon, or whether it belongs to the sun, or the fixed stars, or the planets, or the nebulæ—all this oxygen is alike. And all these molecules of oxygen we find upon the earth must have existed unaltered, or unappreciably unaltered, during the whole of the time the earth has been evolved. Whatever vicissitudes they have gone through, how many times they have entered into combination with iron or silver and been melted down beneath the crust of the earth, or deoxidized and sent up again through the atmosphere, they have remained steadfast to their original form unaltered, the monuments of what they were when the world began. Now, Prof. Clerk Maxwell argues that things which are unalterable, and are exactly alike, cannot have been formed by any natural

process. Moreover, being exactly alike, they cannot have existed forever, and therefore they must have been made. As Sir John Herschel said, "they bear the stamp of the manufactured article."

Now, into these further deductions I do not propose to enter at all. I confine myself strictly to the first of the deductions which Prof. Clerk Maxwell made upon this theory. He said that because these molecules are exactly alike, and because they have not been in the least altered since the beginning of time, therefore they cannot have been produced by any process of evolution. It is just that question which I want to discuss. I want to consider whether the evidence that we have to prove that these molecules are exactly alike is sufficient to make it impossible that they can have been produced by any process of evolution. The position, that this evidence is not sufficient, is evidently by far the easier to defend, because the negative is proverbially hard to prove; and, if any one should prove that a process of evolution was impossible, it would be an entirely unique thing in science and philosophy. In fact, we may see from this example precisely how great is the influence of authority in matters of science.

If there is any name among contemporary natural philosophers to whom is due the reverence of all true students of science, it is that of Prof. Clerk Maxwell. But if any one, not possessing his great authority, had put forward an argument founded apparently upon a scientific basis, in which there occurred assumptions about what things can and what things cannot have existed from eternity, and about the exact similarity of few or more things established by experiment, we should say, "Past eternity; absolute exactness;" and we should pass on to another book. The experience of all scientific culture, for all ages during which it has been a light to men, has shown us that we never do get at any conclusions of that sort. We do not get at conclusions about infinite time or infinite exactness. We get at conclusions which are as nearly true as experiment can show, and sometimes which are a great deal more correct than direct experiment can be, so that we are able actually to correct one experiment by deductions from another; but we never get at conclusions which we have a right to say are absolutely exact; so that, even if we find a man of the highest powers saying that he had reason to believe a certain statement to be exactly true, or that he believed a certain thing to have existed from the beginning exactly as it is now, we must say, "It is quite possible that a man of so great eminence may have found out something which is entirely different from the whole of our previous knowledge, and the thing must be inquired into. But, notwithstanding that, it remains a fact that this piece of knowledge will be absolutely of a different kind from any thing that we knew before."

Now, let us examine the evidence by which we know that the molecules of the same gas are as near as may be alike in weight and in rates of vibration. There were experiments made by Dr. Graham,

late Master of the Mint, upon the rate at which different gases were mixed together. He found that if he divided a vessel by a thin partition made of black-lead or graphite, and put different gases on the two opposite sides, they would mix together nearly as fast as though there was nothing between them. The difference was, that the plate of graphite made it more easy to measure the rate of mixture; and Dr. Graham made measurements and came to conclusions which are exactly such as are required by the molecular theory. It is found by a process of mathematical calculation that the rate of diffusion of different gases depends upon the weight of the molecules. Now, a molecule of oxygen is sixteen times as heavy as a molecule of hydrogen, and it is found upon experiment that hydrogen goes through a septum or wall of graphite four times as fast as oxygen does. Four times four are sixteen. We express that rule in mathematics by saying that the rate of diffusion of gas is inversely as the square root of the mass of its molecules. If one molecule is thirty-six times as heavy as another—the molecule of chlorine is nearly that multiple of hydrogen—it will diffuse itself at one-sixth of the rate.

This rule is a deduction from the molecular theory, and it is found, like innumerable other such deductions, to come right in practice. But now observe what is the consequence of this. Suppose that, instead of taking one gas and making it diffuse itself through a wall, we take a mixture of two gases. Suppose we put oxygen and hydrogen into a vessel which has one side of it made of graphite, and we exhaust the air from the other side, then the hydrogen will go through this wall four times as fast as the oxygen will. Consequently, as soon as one side is full there will be a great deal more hydrogen in it than oxygen—that is to say, that we shall have sifted the oxygen from the hydrogen, not completely, but in a great measure, precisely as by means of a screen we can sift large coals from small ones. Now, suppose, when we have oxygen gas unmixed with any other, the molecules are of two sorts and of two different weights. Then you see that if we make that gas pass through a porous wall, the lighter particles would pass through first, and we should get two different specimens of oxygen gas, in one of which the molecules would be lighter than in the other. The properties of one of these specimens of oxygen gas would necessarily be different from those of the other, and that difference might be found by very easy processes. If there were any perceptible difference between the average weight of the molecules on the two sides of the septum, there would be no difficulty in finding that out. No such difference has ever been observed. If we put any single gas into a vessel, and we filter it through a septum of black-lead into another vessel, we find no difference between the gas on one side of the wall and the gas on the other side. That is to say, if there is any difference it is too small to be perceived by our present means of observation. It is upon that sort of evidence that the state-

ment rests that the molecules of a given gas are all very nearly of the same weight. Why do I say *very nearly?* Because evidence of that sort can never prove that they are exactly of the same weight. The means of measurement we have got may be exceedingly correct, but a certain limit must always be allowed for deviation; yet if the deviation of molecules of oxygen from a certain standard of weight were very small, and restricted within small limits, it would be quite possible for our experiments to give us the results which they do now. Suppose, for example, the variation in the size of the oxygen-atoms was as great as that in the weight of different men, then it would be very difficult indeed to tell by such a process of sifting what that difference was, or in fact to establish that it existed at all. But, on the other hand, if we suppose the forces which originally caused all those molecules to be so nearly alike as they are, to be constantly acting and setting the thing right as soon as by any sort of experiment we set it wrong, then the small oxygen-atoms on one side would be made up to their right size, and it would be impossible to test the difference by any experiment which was not quicker than the processes by which they were made right again.

There is another reason why we are obliged to regard that experiment as only approximate, and as not giving us any exact results. There is very strong evidence, although it is not conclusive, that in a given gas—say in a vessel full of carbonic acid—the molecules are not all of the same weight. If we compress the gas, we find that when in the state of a perfect gas, or nearly so, the pressure increases just in the ratio that the volume diminishes. That law is entirely explained by means of the molecular theory. It is what ought to exist if the molecular theory is true. If we compress the gas further, we find that the pressure is smaller than it ought to be. This can be explained in two ways: First of all we may suppose that the molecules are so crowded that the time during which they are sufficiently near to attract each other sensibly becomes too large a proportion of the whole time to be neglected; and this will account for the change in the law. There is, however, another explanation. We may suppose, for illustration, that two molecules approach one another, and that the speed at which one is going relatively to the other is very small, and then that they so direct one another that they get caught together, and go on circling, making only one molecule. This, on scientific principles, will account for our fact, that the pressure in a gas which is near a liquid state is too small; that instead of the molecules going about singly, some are hung together in couples and some in larger numbers, and making still larger molecules. This supposition is confirmed very strikingly by the spectroscope. If we take the case of chlorine gas, we find that it changes color—that it gets darker as it approaches the liquid condition. This change of color means that there is a change in the rate of vibration which belongs to its compo-

nent parts; and it is a very simple mechanical deduction that the larger molecules will, as a rule, have a slower rate of vibration than the smaller ones—very much in the same way as a short string gives a higher note than a long one. The color of chlorine changes just in the way we should expect if the molecules, instead of going about separately, were hanging together in couples; and the same thing is true of a great number of the metals. Mr. Lockyer, in his admirable researches, has shown that several of the metals and metalloids have various spectra, according to the temperature and the pressure to which they are exposed; and he has made it exceedingly probable that these various spectra, that is, the rates of vibration of the molecules, depend upon the molecules being actually of different sizes. Dr. Roscoe has, a few months ago, shown an entirely new spectrum of the metal sodium, whereby it appears that this metal exists in a gaseous state in four different degrees of aggregation, as a simple molecule, and as three or four or eight molecules together. Every increase in the complication of the molecules—every extra molecule you hang on to the aggregate that goes about together—will make a difference in the rate of the vibration of that system, and so will make a difference in the color of the substance.

So, then, we have an evidence, you see, of an entirely extraneous character, that in a given gas the actual molecules that exist are not all of the same weight. Any experiment which failed to detect this would fail to detect any smaller difference. And here also we can see a reason why, although a difference in the size of the molecules does exist, yet we do not find that out by sifting. Suppose you take oxygen gas consisting of single molecules and double molecules, and you sift it through a plate; the single molecules get through first, but, when they get through, some of them join themselves together as double molecules; and, although more double molecules are left on the other side, yet some of them separate up and make single molecules; so the process of sifting, which ought to give you single molecules on the one side and double on the other, merely gives you a mixture of single and double on both sides; because the reasons which originally decided that there should be just those two forms are always at work, and continually setting things right.

Now let us take the other point in which molecules are very nearly alike; viz., that they have very nearly the same rate of vibration. The metal sodium in the common salt upon the earth has two rates of vibration; it sounds two notes, as it were, which are very near to each other. They form the well-known double line. The two bright yellow lines are very easy to observe. They occur in the spectra of a great number of stars. They occur in the solar spectrum as dark lines, showing that there is sodium in the outer rim of the sun, which is stopping and shutting off the light of the bright parts behind, and all these lines of sodium are just in the same position in the spectrum,

showing that the rates of vibration of all these molecules of sodium all over the universe, so far as we know, are as near as possible alike. That implies a similarity of molecular structure, which is a great deal more delicate than mere test of weight. You may weigh two fiddles until you are tired, and you will never find out whether they are in tune; the one test is a great deal more delicate than the other. Let us see how delicate this test is. Lord Rayleigh has remarked that there is a natural limit for the precise position of a given line in the spectrum, and for this reason. If a body which is emitting a sound comes toward you, you will find that the pitch of the sound is altered. Suppose that omnibuses run every ten minutes in the streets, and you walk in a direction opposite to that in which they are coming, you will obviously pass more omnibuses in an hour than if you walked in an opposite direction. If a body emitting light is coming toward you, you will find more waves in a certain direction than if it was going from you; consequently, if you are approaching a body emitting light, the light will come quicker, the vibration will be of shorter duration, and the light will be higher up in the spectrum—it will be more blue. If you are going away from the body, then the rate is slower, the light is lower down on the spectrum. By means of variations in the positions of certain known lines of that character, the actual rate of approach of certain fixed stars to the earth has been measured, and the rate of going away of certain other fixed stars has also been measured. Suppose we have a gas which is glowing in a state of incandescence, all the molecules are giving out light at a certain specified rate of vibration; but some of these are coming toward us at a rate much greater than seventeen miles a minute, because the temperature is higher when the gas is glowing, and others are also going away at a much higher rate than that. The consequence is, that instead of having one sharply-defined line on the spectrum, instead of having light of exactly one bright color, we have light which varies between certain limits.

If the actual rate of the vibration of the molecules of the gas were marked down upon the spectrum, we should not get that single bright line there, but we should get a bright band overlapping it on every side. Lord Rayleigh calculated that, in the most favorable circumstances, the breadth of this band would not be less than one-hundredth of the distance between the sodium-lines. It is precisely upon that experiment that the evidence of the exact similarity of molecules rests. We see, therefore, from the nature of the experiment, that we should get exactly the same results if the rate of vibration of all the molecules was not exactly equal, but varied within certain very small limits. If, for example, the rates of vibration varied in the same way as the heads of different men, then we should get very much what we get now from the experiment. From these two sources of evidence, then, the evidence of their being of the same weight and degree of

vibration, all that we can conclude is, that whatever differences there are in their weights, and whatever differences there are in their degrees of vibration, these differences are too small to be found out by our present modes of measurement, and that is precisely all that we can conclude in every similar question of science.

Now, how does this apply to the question whether it is possible for molecules to have been evolved by natural processes? I do not understand, myself, how, even supposing that we knew that they were exactly alike, we could know from that, for certain, that they had not been evolved, because there is only one case of evolution that we know any thing at all about, and that we know very little about yet—that is the evolution of organized beings. The processes by which that evolution takes place are long, cumbrous, and wasteful processes of natural selection and hereditary descent. They are processes which act slowly, which take a great lapse of ages to produce their natural effects. But it seems to me quite possible to conceive, in our entire ignorance of the subject, that there may be other processes of evolution which result in a definite number of forms—those of the chemical elements—just as these processes of the evolution of organized beings have resulted in a greater number of forms. All that we know of the ether shows that its actions are of a rapidity very much exceeding any thing we know of the motions of visible matter. It is a possible thing, for example, that mechanical conditions should exist, according to which all bodies must be made of regular solids, that molecules should all have flat sides, and that these sides should all be of the same shape. I suppose it is just conceivable that it might be impossible for a molecule to exist with two of its faces different. In that case we know there would be just five shapes for a molecule to exist in, and these would be produced by process of evolution. Now, the forms of various matter that we know, and that chemists call elements, seem to be related one to another very much in that sort of way: that is, as if they rose out of mechanical conditions which only rendered it possible for a certain definite number of forms to exist, and which, whenever any molecule deviates slightly from one of these forms, would immediately operate to set it right again. I do not know at all—we have nothing definite to go upon—what the shape of a molecule is, or what is the nature of the vibration it undergoes, or what its condition is compared with the ether; and in our absolute ignorance it would be impossible to make any conception of the mode in which it grew up. When we know as much about the shape of a molecule as we do about the solar system, for example, we may be sure of its mode of evolution as we are of the way in which the solar system came about; but, in our present ignorance, all we have to do is to show that such experiments as we can make do not give us evidence that it is absolutely impossible for molecules of matter to have been evolved out of ether by natural processes.

The evidence which tells us that the molecules of a given substance are alike, is only approximate. The theory leaves room for certain small deviations, and consequently if there are any conditions at work in the nature of the ether, which render it impossible for other forms of matter than those we know of to exist, the great probability is, that when by any process we contrive to sift molecules of one kind from molecules of another, these very conditions at once bring them back and restore to us a mass of gas consisting of molecules, whose average type is a normal one.

Now, I want to consider a speculation of an entirely different character. A remark was made about thirty years ago, by Sir William Thompson, upon the nature of certain problems in the deduction of heat. These problems had been solved by Fourier, many years before, in a beautiful treatise. The theory was, that if you knew the degree of warmth of a body, then you could find what would happen to it afterward, you would find how the body would gradually cool. Suppose you put the end of a poker in the fire and make it red hot, that end is very much hotter than the other end, and if you take it out and let it cool, you will find that heat is traveling from the hot end to the cool end, and the amount of this traveling and the temperature at either end of the poker can be calculated with great accuracy. That comes out of Fourier's theory. Now, suppose you try to go backward, in time, and take the poker at any instant when it is about half cool, and say, "This equation—does it give me the means of finding out what was happening to it before this time, in so far as that state of things has been produced by cooling?" You will find the equation will give you an account of the state of the poker before the time when it came into your hands, with great accuracy up to a certain point, but beyond that point it refuses to give you any more information, and it begins to talk nonsense. It is in the nature of a problem of the conduction of heat, that it allows you to trace the forward history of it to any extent you like; but it will not allow you to trace the history of it backward, beyond a certain point. There is another case in which a similar thing happens. There is an experiment in the excellent manual, "The Boy's Own Book," which tells you that if you put some beer into a glass half full, and put some paper on it, and then pour in water carefully, and draw the paper out without disturbing the two liquids, the water will rest on the beer. The problem, then, is to drink the beer without drinking the water, and it is accomplished by means of a straw. Let us suppose these two resting on each other, we shall find that they begin to mix, and it is possible to write down the equation, which is exactly of the same form as the equation for the conduction of heat, and it would tell you how much water should have gone at any given time after the mixture began. So that, given the water and the beer half mixed, you could trace forward the process of mixing, and measure it with accuracy,

and give a perfect account of it; but if you attempt to trace that back you will have a point where the equation will stop, and will begin to talk nonsense. That is the point where you took away the paper, and allowed the mixing to begin. If we apply that same consideration to the case of the poker, and try to trace back its history, you will find that the point where the equation begins to talk nonsense is the point where you took it out of the fire. The mathematical theory supposes that the process of conduction of heat has gone on in a quiet manner, according to certain defined laws, and that if at any time there was a catastrophe, one not included in the laws of the conduction of heat, then the equation could give you no account of it. There is another thing which is of the same kind. That is the transmission of fluid friction. If you take your tea in your cup, and stir it round with a spoon, it won't go on circulating round forever, but comes to a stop; and the reason is, that there is a certain friction of the liquid against the sides of the cup, and of the different parts of the liquid with one another. Now, the friction of the different parts of a liquid or a gas is precisely a matter of mixing. The particles which are going fast, and are in the middle, not having been stopped by the side, get mixed, and the particles at the side going slow, get mixed with the particles in the middle. This process of mixing can be calculated, and it leads to an equation of exactly the same sort as that which applies to the conduction of heat. We have, therefore, in these problems, a natural process which consists in mixing things together, and this always has the property that you can go on mixing them forever, without coming to any thing impossible; but if you attempt to trace the history of the thing backward, you must always come to a state which could not have been produced by mixing, namely, a state of complete separation.

Now, upon this remark of Sir W. Thompson's, which you will find further expressed in Mr. Balfour Stewart's book on the "Conservation of Energy," a most singular doctrine has been founded. These writers have been speaking of a particular problem, on which they were employed at the moment. Sir W. Thompson was speaking of the deduction of heat, and he said this heat-problem leads you back to a state which could not have been produced by the conduction of heat. And so Prof. Clerk Maxwell, speaking of the same problem, and also of the diffusion of gases, said there was evidence of a limit in past time to the existing order of things, when something else than mixing took place. But a most eminent man, who has done a great deal of service to mankind, Prof. Stanley Jevons, in his very admirable book, "The Principles of Science," which is simply marvellous for the number of examples illustrating logical principles which he has drawn from all kinds of regions of science, and for the small number of mistakes that occur in it, takes this remark of Sir W. Thompson's, and takes out two very important words, and puts in two other very

important words. He says, "We have here evidence of a limit of a state of things which could not have been produced by the previous state of things according to the known laws of Nature." It is not according to the known laws of Nature, it is according to the known laws of conduction of heat, that Sir William Thompson is speaking; and that mistake illustrates the fallacy of concluding that, if we consider the case of the whole universe, we should be able, suppose we had paper and ink enough, to write down an equation which would enable us to make out the history of the world forward, as far forward as we liked to go, but if we attempted to calculate the history of the world backward, we should come to a point where the equation would begin to talk nonsense, we should come to a state of things which could not have been produced from any previous state of things, by any known natural laws. You will see at once that that is an entirely different statement. The same doctrine has been used by Mr. Murphy, in a very able book, "The Scientific Bases of Faith," to build upon it an enormous superstructure. I think the restoration of the Irish Church was one of the results of it, but this doctrine is founded, as I think, upon a pure misconception. It is founded entirely upon forgetfulness of the condition under which the remark was originally made. All these physical writers, knowing what they were writing about, simply drew such conclusions from the facts which were before them as could be reasonably drawn. They say, "Here is a state of things which could not have been produced by the circumstances we are at present investigating." Then your speculator comes, he reads a sentence and says, "Here is an opportunity for me to have my fling." And he has his fling and makes a purely baseless theory about the necessary origin of the present order of Nature at some definite point of time which might be calculated. But, if we consider the matter, we shall see that this is not in any way a consequence of the theory of the deduction of heat. If we apply that to the case of the earth, we find that at present there is a certain distribution of temperature in the interior of it, there is a law according to which the temperature increases as we go down, and no doubt if we made further investigations, we should find that if we went deeper an accurate law would be found, according to which the temperature increases as we go downward.

Now, assuming this to be so, taking this as the basis of our problem, we might endeavor to find out what was the history of the earth in past times, and when it began cooling down. That is exactly what Sir William Thompson has done. When we attempt it, we find that there is a definite point to which we can go, and at which our equation talks nonsense. But we do not conclude that at that point the laws of Nature began to be what they are; that is the point where the earth began to solidify; that is a process which is not a process of the deduction of heat, and so the thing cannot be given by the

equation. Now, that point is given definitely as a point of time, not with great accuracy, but still as near as we can expect to get it, with such means of measuring as we have, and Sir William Thompson has calculated that the earth must have solidified at some time a hundred millions or two hundred millions of years ago; and there we arrive by a present state of things at the beginning of the process of cooling the earth which is going on now. Before that it was cooling as a liquid, and in passing from the liquid to the solid state there was a catastrophe which introduced a new rate of cooling, so that by means of that law we do come to a time when the earth began to assume the present state of things—not that of the existence of the universe at all; we do not give the time of the commencement of the universe, but simply the structure of the earth. If we went farther back, we might make a further calculation and find how long the earth had been in a liquid state. We should come to another catastrophe, and say at that time, not that the universe began to exist, but that the present earth passed from the gaseous to the liquid state. And if we went farther back still we should probably find the earth falling together out of a great ring of matter surrounding the sun, and distributed over its orbit. The same thing is true of every body of matter: if we trace its history back, we come to a certain time at which the catastrophe took place, and if we were to trace back the history of all the bodies of the universe in that way we should continually see them separating up, and falling together, as they have done. What they have actually done is to fall together and get solid. If we should reverse the process we should see them separating and getting cool, and, as a limit to that, we should find that all these bodies would be resolved into molecules, and all these would be flying away from each other. There would be no limit to that process, and we could trace it as far back as ever we liked to trace it. So that on the assumption, a very large assumption, that the present constitution of the laws of geometry and mechanics has held good during the whole of past times, we should be led to the conclusion that at an inconceivably long time ago the universe did consist of ultimate molecules, all separate from one another, and approaching one another, because we have to reverse our former process. Instead of their being at a great distance from one another, and all traveling toward some place where they would meet, the reverse would be the case. Then you would have the process of chlorine going on in these bodies, exactly as we find it going on now, but you will observe that we do not come to such a catastrophe as implies that we have to stop these laws of Nature. We come to something of which we cannot make any further calculation; we find that, however far we like to go back, we approximate to that actual state of things, but never actually get to it. Here we have a doctrine about the beginning of things. First, we have a probability, about as correct as science can make it, of the

beginning of the present state of things on the earth, of the fitness of the earth for habitation; and then we have a probability which is an exceedingly small one, which is certainly put in this form, that we do not know any thing at all about the beginning of the universe as a whole.

The reason why I say that we do not know any thing at all of the beginning of the universe is, that we have no reason whatever for believing that what we at present know of the laws of geometry are exactly and absolutely true at present, or that they have been even approximately true for any period of time, further than we have direct evidence of. The evidence we have of them is founded on experience, and we should have exactly the same experience of them now, if those laws were not exactly and absolutely true, but were only so nearly true that we could not observe the difference, so that in making that assumption, that we may argue upon the absolute uniformity of Nature, and supposing them to have remained exactly as they are, we are assuming something we know nothing about. My conclusion then, is, that we do know, with great probability, of the beginning of the habitability of the earth about one hundred or two hundred millions of years back, but that of the beginning of the universe we know nothing at all.

Now, let us consider what we can find out about the end of things. The life which exists upon the earth is made by the sun's action, and it depends upon the sun for its continuance. We know that the sun is wearing out, that it is cooling, and although this heat which it loses day by day is made up in some measure, perhaps completely, at present, by the contraction of its mass, yet that process cannot go on forever. There is only a certain amount of energy in the present constitution of the sun, and, when that has been used up, the sun cannot go on giving out any more heat. Supposing, therefore, the earth remains in her present orbit about the sun, seeing that the sun must be cooled down at some time, we shall all be frozen out. On the other hand, we have no reason to believe that the orbit of the earth about the sun is an absolutely stable thing. It has been maintained for a long time that there is a certain resisting medium which the planets have to move through, and it may be argued from that, that in time all the planets must be gradually made to move slower in their orbits, and so to fall in toward the sun. But, on the other hand, the evidences upon which this assertion was based, the movement of Encke's comet and others, has been quite recently entirely overturned by Prof. Tait. He supposes that these comets consist of bodies of meteors. Now, it was proved, a long time ago, that a mass of small bodies traveling together in an orbit about a central body will always tend to fall in toward it, and that is the case with the rings of Saturn. So that, in fact, the movement of Encke's comet is entirely accounted for on the supposition that it is a swarm of meteors, without regarding

the assumption of a resisting medium. On the other hand, it seems exceedingly natural to suppose that some matter in a very thin state is diffused about the planetary spaces. Then we have another consideration: just as the sun and moon make tides upon the sea, so the planets make tides upon the sun. If we consider the tide which the earth makes upon the sun, instead of being a great wave lifting the mass of the sun up directly under the earth, it lags behind, the result is that the earth, instead of being attracted to the sun's centre, is attracted to a point behind the centre. That retards the earth's motion, and the effect of this upon the planet is to make its orbit larger. That planet disturbing all the other planets, the consequence is, that we have the earth gradually going away from the sun, instead of falling into it.

In any case, all we know is that the sun is going out. If we fall into the sun then we shall be fried; if we go away from the sun, or the sun goes out, then we shall be frozen. So that, so far as the earth is concerned, we have no means of determining what will be the character of the end, but we know that one of these two things must take place in time. But in regard to the whole universe, if we were to travel forward as we have traveled backward in time, consider things as falling together, we should come finally to a great central mass, all in one piece, which would send out waves of heat through a perfectly empty ether, and gradually cool itself down. As this mass got cool it would be deprived of all life or motion; it would be just a mere enormous frozen block in the middle of the ether. But that conclusion, which is like the one that we discussed about the beginning of the world, is one which we have no right whatever to rest upon. It depends upon the same assumption that the laws of geometry and mechanics are exactly and absolutely true, and that they have continued exactly and absolutely true for ever and ever. Such an assumption we have no right whatever to make. We may therefore, I think, conclude about the end of things that, so far as the earth is concerned, an end of life upon it is as probable as science can make any thing, but that in regard to the universe we have no right to draw any conclusion at all. So far we have considered simply the material existence of the earth; but of course our greatest interest lies not so much with the material things upon it, its organized things, as with another fact which goes along with that, and which is an entirely different one—the fact of the consciousness that exists upon the earth. We find very good reason indeed to believe that this consciousness in the case of any organism is itself a very complex thing, and that it corresponds part for part to the action of the nervous system, and more particularly of the brain of that organized thing. There are some whom such evidence has led to the conclusion that the destruction which we have seen reason to think probable of all organized beings upon the earth will lead also to the final destruction of the conscious-

ness that goes with them. Upon this point I know there is great difference of opinion among those who have a right to speak. But, to those who do see the cogency of the evidences of modern physiology and modern psychology in this direction, it is a very serious thing to consider that not only the earth itself and all that beautiful face of Nature we see, but also the living things upon it, and all the consciousness of men, and the ideas of society, which have grown up upon the surface, must come to an end. We who hold that belief must just face the fact and make the best of it; and I think we are helped in this by the words of that Jew philosopher who was himself a worthy crown to the splendid achievements of his race in the cause of progress during the middle ages, Benedict Spinoza. He said, "The freeman thinks of nothing so little as of death, and his contemplation is not of death but of life." Our interest, it seems to me, lies with so much of the past as may serve to guide our actions in the present, and to intensify our pious allegiance to the fathers who have gone before us, and the brethren who are with us; and our interest lies with so much of the future as we may hope will be appreciably affected by our good actions now. Beyond that, as it seems to me, we do not know, and we ought not to care. Do I seem to say, "Let us eat and drink, for to-morrow we die?" Far from it; on the contrary, I say, "Let us take hands and help, for this day we are alive together."—*Fortnightly Review.*

SEXUAL CEREBRATION.

By ELY VAN DE WARKER, M. D.

BY sexual cerebration is meant the existence of sex in the emotional and ideo-motor psychical nature of women and men, from which originate *per se* emotions and states of consciousness which distinguish and give character to the intellection of the sexes. It is sex in mental, as distinguished from sex in physical development. It is to mental operations what the prism is to light—a medium of refraction; a bending, as it were, of the axis of thought.

Having postulated that certain differences exist mentally between the sexes, is it possible to determine the extent and nature of the difference? Is it also possible to trace this difference to a sexual factor? It is evident that, if we can reach the truth, approximately, in the first question, the establishment of the second is easy.

There appears to me but one way of studying this question. The old speculative method of investigating metaphysical questions must be abandoned. We must grapple with this psychological problem from a few fixed points; like points of triangulation, to measure distances which otherwise may remain unknown. We must reason from

the known to the unknown. These fixed points are to be found in anatomy and physiology. We may also study certain voluntary acts of the sexes in the aggregate, and estimate the difference in the result. The relations between the sexes will also furnish facts from which mental differences may be estimated.

Accepting Dr. Carpenter as the exponent of thought upon the physiology of mental action, we shall give his estimate of the cerebrum, or "brain," as "ministering, so far as any material instrument may do, to the exercise of these psychical powers which, in man, exhibit so remarkable a predominance over the mere animal instincts." The brain, anatomically, may be classed among the ganglia, having its function more clearly defined than is usual with great nerve-centres. It is not an assumption, then, which will provoke dissent among modern physiologists, to assume the brain as the "organ of thought;" not in the sense that it secretes thought, but that it presides in its own way over its special function, that of intellection. It is the operation of the brain in its functional capacity which gives to each individual his mental peculiarities. These differences in mental action which define the individual must represent differences in functional activity. Taking this view of the physiology of thought, it is just to say that this exhibit of mental differences is the measure of functional, if not of structural, peculiarities, in the great brain-ganglion. If this is true of several individuals, it must also be true of the sexes. The mental traits, which define the sexes intellectually, afford a measure of either functional or structural differences in the cerebral ganglion. It is very possible that, histologically, any structural differences which may exist in the ganglia of either individuals or the sexes may never be determined. But the drift of modern thought and research tends to show that such differences do exist, and it is as true approximately as the undulatory theory of light. Many of the functional attributes of sex are presided over by ganglia having special reference to these functions, and these groups of nerve-centres in the sexes, one being the analogue of the other anatomically, must differ widely in function, notwithstanding their similarity of location and structure. When we take into consideration that the forces of organic and functional life represent simply the sum of ganglionic activity, a just idea may be formed of the extent to which this activity must be differentiated in the sexes. It is simply necessary to extend the field of ganglionic action to the brain, the supreme ganglion of all, in order to realize the fact that here also functional differences must exist. That the brain possesses functions in common to the sexes in no wise renders it impossible to perform its part as an organ embraced in the sexual cycle. The relations existing between the sexes are mutually voluntary, and involve more or less of mental action. As these relations represent the opposite poles of structural and functional life, this mutuality must also represent phases of mental action which exist as sexual traits.

Concerning many of these relations we know that men and women do not think alike, and that these differences are radical ones, and have existed many years, and yet continue to exist. Take the labor and the ballot questions as the most widely known of the points of disagreement, which seem to have their origin in sexual mental attributes. But, even upon these questions, we find many men and women thinking and acting alike. Yet these are the exception, and not the rule; which confirms my idea of the difference in the results reached by the mental processes of the sexes: for surely the want of agreement must be a radical one in which it is a rare exception for the two types of mind to approach each other upon matters other than the organic emotions. Keeping in view the accepted fact that the brain, as an organ, or nerve-centre, is the seat of mental action, with which its structure, either in its histological elements or its relative proportion of parts, is more or less intimately connected, it seems reasonable to refer these differences in the results of sexual mental processes to structural rather than to any ephemeral cause. If we estimate the sexual factor in brain-development by the aggregate of results attained by the sexes, the way is clearer. The known average excess in weight in the male brain is the most probable coefficient of this excess in results. The face of Nature has fairly been changed by man's labor. The vast systems of railroads, of canals, of mountains pierced by tunnels, of lines of telegraph and cables, the steamships, the vast engines of war, the great emporiums of commerce, the results reached by masterly labors in science which underlie all these grand results, and in which women have been the accessories rather than the collaborators, prove that some factor, other than superior strength of bone and muscle, has led to this vast excess in results reached by man. These results represent brain-labor; and to what cause can we assign it, if not to this great development of the brain of man over that of woman?

In the organic emotions, and in the play of those finer feelings which form distinguishing mental traits of the sexes, we have the same reason to seek for a physical basis. As these mental traits are analyzed in the course of the paper, it will become more evident that the brain in the sexes is an organ embraced structurally in the sexual cycle. With this sexual factor existing in brain-structure, can woman ever hope, in entering the field of man's labor, to do his work in man's way? Will she write sermons, draw up a brief, or treat disease with the same facts before her, in the way of man? I do not believe I show disrespect to the sex when I answer, No. Women in literature have occupied a distinctive place. A book or an article in which the sex of the writer cannot be detected, no matter how studiously concealed, forms an event in literature. When woman labors either with her hands or head, notwithstanding she reaches the same result as man, she labors in her own way. All this, I believe, points not so

much to a womanly habit, as to a womanly brain as well as body. Sex is a law to body as well as brain. Sex pervades all Nature, not for the sake of the individual, but for that of the species.

In the insect-world, some bright little creature lives but a few hours, deposits its egg and dies. The sum of its life is sex. Not less do I believe does man, notwithstanding the grandeur of his intellect, conform to the same inexorable law.

Before we enter upon the more difficult part of our subject, there are certain conceded mental attributes peculiar to the sexes which are legitimate subjects of investigation. I say there are mental differences conceded; because, without thought, we include them in our ideal of women, or of men. In the same manner, we need not recall to our minds, or to the minds of others, that women are characterized nearly the world over by peculiarities of dress which distinguish them as a sex. It is part of our ideal of women, because they have ever been associated with such peculiarities. In literature and art, woman has maintained her lofty place, separated more widely from man by her mental trait than by her differences in form. It has ever been a theme more of mind than of matter which has inspired the poet to entwine women in his graceful verse. Her truth, her gentleness, her constancy, these are immortal themes; these are the chords of her nature which have found responsive vibrations in the hearts of poets, and made the monuments of their genius eternal. When the poet and the artist see more in the enticements of woman's form than in her mind, the best of men shrink from the picture. Is it not because our ideal woman in art is associated more with sexual graces of mind than of body? When that strange poet, Algernon Swinburne, clothed in his matchless English the gospel of the flesh, the world of literature recoiled. This union of the gentle nature of woman as a theme with the beautiful in literature, dates back to the cradle of art. Now, what are these conceded mental differences between the sexes.—"Soothing, unspeakable charm of gentle womanhood! which supersedes all acquisitions, all accomplishments," says George Eliot, in "Scenes of Clerical Life."

We may assume gentleness of mind as a sexual mental trait. It does not spring from any process of conscious reasoning. It has no main-spring in a sense of expediency. Unconsciousness and spontaneity are the conditions of its existence. The practical bearing of this paper is to estimate the value of these mental traits as affecting the affairs of daily life. Necessarily, therefore, we must have an approximate standard of measurement. I seek this standard in that class which usually deals with the active affairs of life—the masculine type of mind. Not only for this reason do I select this criterion; but, also, this is the type women are endeavoring to reach in essaying a career in the professions. The two types of mind, masculine and feminine, by mutual contrast afford the surest indication of sexual

differences in intellection. This gentleness of woman has found its way into the argument as something definite, as a descriptive trait of character, yet by itself is nameless. Relating to woman as it chiefly does, it seems to consist of a mobility and pliability of character, an unconscious avoidance of harshness and fixity of thought. Not a want of fixity as indicating fickleness of character, but implying concessions to the wishes of others. This gentleness of mental habitude in women, which so clearly isolates the psychical condition of the sexes, finds its factor in sexual differences. Unavoidably, this takes approximate force. Reasoning cannot make it clearer that this type of woman is an expression of sex in mind. We see this feminine type of mind associated with certain bodily configurations which are equally expressive of sex. We also find exceptions to this form of sexual cerebration. There are women who approach more or less nearly in positiveness and habitual harshness to the masculine type. With this there is almost invariably associated masculine development of form. Masculine brawn, bone and muscle, shaded and toned down by the irrepressible presence of sex, define this phase of the feminine mind. The voice approaches a manly compass, the down upon the upper lip becomes short, delicate hairs; the stature exceeds the average of woman's; the limbs are muscular and strong. With these bodily powers of aggression there is a natural outgrowth of mental belligerence. This is a law of Nature. The man who shrinks from a physical contest with his fellows is one of conscious bodily weakness. His body measures, therefore, the extent of mental aggressiveness. Not necessarily do these women possess the male intellect; they simply approach the male type in this single aspect of their characters, other and equally feminine attributes of mind existing in full force. But, as demonstrating a sexual origin for this traditional and actual gentleness of the female mind, the fact that certain departures from the typical feminine form are associated with equally positive analogies to the typical masculine mind, seems to me to be conclusive.

These two conditions of mind existing in full force tend to place the sexes at the opposite poles of human actions, that of demanding and yielding, that of giving and receiving. George Eliot is right in saying that this feature of mental character supersedes all acquisitions, all artificial acquirements. Education and refinement may lend it additional attractiveness, but it is a primordial sexual trait of mind —the brightest gem in woman's chaplet of mental charms, around which may cluster other and equally attractive traits without impairing its lustre.

I believe it to be evident that the opposite psychical conditions of the sexes under consideration determine for men and women their careers in society—to one the strife and struggle with the world, to the other the gentle occupations of the home. From the male sex we may obtain a forcible example of how potent is the sexual factor in

much to a womanly habit, as to a womanly brain as well as body. Sex is a law to body as well as brain. Sex pervades all Nature, not for the sake of the individual, but for that of the species.

In the insect-world, some bright little creature lives but a few hours, deposits its egg and dies. The sum of its life is sex. Not less do I believe does man, notwithstanding the grandeur of his intellect, conform to the same inexorable law.

Before we enter upon the more difficult part of our subject, there are certain conceded mental attributes peculiar to the sexes which are legitimate subjects of investigation. I say there are mental differences conceded; because, without thought, we include them in our ideal of women, or of men. In the same manner, we need not recall to our minds, or to the minds of others, that women are characterized nearly the world over by peculiarities of dress which distinguish them as a sex. It is part of our ideal of women, because they have ever been associated with such peculiarities. In literature and art, woman has maintained her lofty place, separated more widely from man by her mental trait than by her differences in form. It has ever been a theme more of mind than of matter which has inspired the poet to entwine women in his graceful verse. Her truth, her gentleness, her constancy, these are immortal themes; these are the chords of her nature which have found responsive vibrations in the hearts of poets, and made the monuments of their genius eternal. When the poet and the artist see more in the enticements of woman's form than in her mind, the best of men shrink from the picture. Is it not because our ideal woman in art is associated more with sexual graces of mind than of body? When that strange poet, Algernon Swinburne, clothed in his matchless English the gospel of the flesh, the world of literature recoiled. This union of the gentle nature of woman as a theme with the beautiful in literature, dates back to the cradle of art. Now, what are these conceded mental differences between the sexes.—"Soothing, unspeakable charm of gentle womanhood! which supersedes all acquisitions, all accomplishments," says George Eliot, in "Scenes of Clerical Life."

We may assume gentleness of mind as a sexual mental trait. It does not spring from any process of conscious reasoning. It has no main-spring in a sense of expediency. Unconsciousness and spontaneity are the conditions of its existence. The practical bearing of this paper is to estimate the value of these mental traits as affecting the affairs of daily life. Necessarily, therefore, we must have an approximate standard of measurement. I seek this standard in that class which usually deals with the active affairs of life—the masculine type of mind. Not only for this reason do I select this criterion; but, also, this is the type women are endeavoring to reach in essaying a career in the professions. The two types of mind, masculine and feminine, by mutual contrast afford the surest indication of sexual

differences in intellection. This gentleness of woman has found its way into the argument as something definite, as a descriptive trait of character, yet by itself is nameless. Relating to woman as it chiefly does, it seems to consist of a mobility and pliability of character, an unconscious avoidance of harshness and fixity of thought. Not a want of fixity as indicating fickleness of character, but implying concessions to the wishes of others. This gentleness of mental habitude in women, which so clearly isolates the psychical condition of the sexes, finds its factor in sexual differences. Unavoidably, this takes approximate force. Reasoning cannot make it clearer that this type of woman is an expression of sex in mind. We see this feminine type of mind associated with certain bodily configurations which are equally expressive of sex. We also find exceptions to this form of sexual cerebration. There are women who approach more or less nearly in positiveness and habitual harshness to the masculine type. With this there is almost invariably associated masculine development of form. Masculine brawn, bone and muscle, shaded and toned down by the irrepressible presence of sex, define this phase of the feminine mind. The voice approaches a manly compass, the down upon the upper lip becomes short, delicate hairs; the stature exceeds the average of woman's; the limbs are muscular and strong. With these bodily powers of aggression there is a natural outgrowth of mental belligerence. This is a law of Nature. The man who shrinks from a physical contest with his fellows is one of conscious bodily weakness. His body measures, therefore, the extent of mental aggressiveness. Not necessarily do these women possess the male intellect; they simply approach the male type in this single aspect of their characters, other and equally feminine attributes of mind existing in full force. But, as demonstrating a sexual origin for this traditional and actual gentleness of the female mind, the fact that certain departures from the typical feminine form are associated with equally positive analogies to the typical masculine mind, seems to me to be conclusive.

These two conditions of mind existing in full force tend to place the sexes at the opposite poles of human actions, that of demanding and yielding, that of giving and receiving. George Eliot is right in saying that this feature of mental character supersedes all acquisitions, all artificial acquirements. Education and refinement may lend it additional attractiveness, but it is a primordial sexual trait of mind —the brightest gem in woman's chaplet of mental charms, around which may cluster other and equally attractive traits without impairing its lustre.

I believe it to be evident that the opposite psychical conditions of the sexes under consideration determine for men and women their careers in society—to one the strife and struggle with the world, to the other the gentle occupations of the home. From the male sex we may obtain a forcible example of how potent is the sexual factor in

shaping the mental character of the sexes. Men reduced to a condition of eunuchism afford a wonderful contrast to men in the normal condition. It is upon the cerebrum and on its function of cerebration that some of its most marked effects are to be observed. He ceases to be fit for war, and is of service only in the pursuits of peace. He is no longer capable of daring to assert his rights, and, of all beings, is a fit subject for a slave. Not only is he made a coward, but the moral senses are weakened, and he may be safely delegated to execute the cruelty of others. It does not seem, then, to be any thing but a legitimate deduction that this radical difference, intellectually, between the normal man and eunuchism is the participation of the brain in the generic cycle, and one phase of sexual cerebration.

Through all the females of the mammalia, there exists a feeling toward their young called the *maternal instinct*. There is no necessity here of going into the question of instinct among animals, as to whether it partakes of the nature of an intellectual process. Whatever be its nature, it is evidently a part of generation, and as such is eminently sexual in its origin. In dealing with this feeling in the human female, although it may have a rudimentary intellectual source, yet it is lifted above the level of instinctive feeling, and becomes a part of her emotional nature. "The intimate and essential relation of emotions to the ideas, which they equal in number and variety, is sufficient to prove that the law of progress from the general and simple to the special and complex prevails in their development" (Maudsley). Thus it is that an instinctive feeling in lower animals, without which the reproductive faculty would be totally defeated, becomes the maternal emotion in its simplest form in the human being; and, by carrying on this evolution from the simple to the complex, produces a complete modification of the psychical tone. Here, also, we may gain a clearer insight into the nature of the maternal feeling by contrasting it with the paternal feeling.[1] This emotion is a state of the mind which obtains the conditions of its existence from the same physical faculty—that of reproduction; and although it is closely related to the expression of the maternal feeling in the more developed state of the emotion, yet, in its fundamental form, it differs widely.

Thus, among the male of the mammalia in which it is not entirely absent, it mostly assumes the form of abstaining from injury, while in the female of the same species it exists as a protecting and maintaining instinct.

In the human race, the same emotion receives a shadow cast from its primal origin in animals. In the human female, in the child-bearing period, it exists as a love, active or passive, for all children; while in men, during the more active period of manhood, it exists as a gentle tolerance of children, until called out in its active form by his own

[1] The word "feeling" is here used, not in its idiomatic sense, but as a state of consciousness.

paternity. Notice from this that even the lofty elevation of intellectual man, and exalted yet higher by the force of education, has not been sufficient to change beyond recognition this emotion in its relative condition and quality as it exists among animals.

We cannot separate the mental from the bodily life. When we scan the deeper relation of things in their genesis, there are displayed in closest connection continuity of parts and functions (Maudsley). The maternal emotion exists potentially in the intellection of the healthy adult woman as a natural outcome of the existence of organs and functions which render possible the occasion of its activity. As the time approaches for its full development, any observing physician can perceive the latent emotion assuming shape and direction to a definite end. Numberless cares and solicitudes, colored by the tenderest of anticipations, become dominant in her volition. Not once, but innumerably, has a star over Bethlehem shed its lucid light in the hearts of watchers, and roused from the depths of latent emotions, half stifled with agony, the infinite possibilities of a mother's love. De Quincey, who intellectually stood so near the verge of the impossible in thought, and measured the heights and fathomed the depths of hearts, looked upon this kindling of the maternal emotion, at the supremest moment of a woman's life, with the eyes of a seer. Until I read this,[1] there always seemed an incongruity in the piercing grief of a mother over the death of her new-born. One with whom there was associated not a single earthly emotion, save that of maternity, but who was freshly linked with a hundred pangs, received upon its little, scarcely human face, the most keenly-felt of maternal tears. The reason is plain. The emotion of maternity exceeds reason, transcends imagination, and is brought forth from the depths of organic life as part of the mystery of reproduction. As from the state of eunuchism we gained a knowledge of the sexual origin of certain attributes which distinguish man intellectually, so, from the condition resulting after the operation of spaying in animals, we may obtain additional evidence of the origin of the maternal feeling. Animals so treated have a great aversion for the young of their own species; that which was the maternal instinct in the normal animal becomes an instinctive hatred in the unsexed one. Here it is evident that the presence of organs whose existence is necessary to the completion of function is a prime factor in the creation of an overruling instinct. I have already drawn attention to the great resemblance between the maternal emotion in human beings and the maternal instinct in animals, and it does not seem to be unreasonable to trace both emotion and instinct to a common and physical cause. It is not in the power of a woman, normal psychically and physically, to repress her maternal emotion in the presence of her new-born, and in this respect she is allied to her sister animals. But the analogy here ceases. The

[1] "Suspiria de Profundis."

woman is gifted with intellect, the animal is not; the woman has memory, the animal has none; and thus it is that the maternal instinct ceases with the necessity of providing food for the young; the maternal emotion in the human mother ends only with her life. But yet again, how tender is the mother with her new-born babe, compared to the exhibition of the same emotion toward her half-grown child!

The differentia that exist between the maternal and paternal emotions are such as characterize other expressions of sexual cerebration. I have already called attention to some of them. Among men, as the mind assumes its higher moral and intellectual development, these emotions are more nearly alike in the sexes, so far as constancy and care are concerned. If we take into consideration the frequency of the charge against men of desertion of family and children, and the extreme rarity of this charge against woman, we perceive that the paternal emotion must be accompanied by a certain degree of moral sense in order to equal the maternal emotion, which alone, and unaided by any mental accessory, is, as a rule, capable of the most heroic sacrifice. I think I may end our study of the maternal emotion here, with no doubt in my mind, and with but little chance of valid objections on the part of others, that it is purely the result of sexual organization; that not indirectly, but directly, it is the psychical component of the reproductive faculty, and as such is notably an example of sexual cerebration.

Love is the attraction between the sexes. The word is wrongly used to express a great variety of relations and emotions. Spinoza says that, "between appetite and desire there is no difference, except so far as the latter implies consciousness; desire is self-conscious appetite." It is important that the presence of consciousness be not allowed to obscure the fundamental condition of things in the brain. Because of the affinity between vital structure and instinct or impulse, the organic reaction becomes evident as a condition of consciousness, overlooking the primary cause. "The striving after a pleasing impression, or the effort to avoid a painful one, is at bottom a physical consequence of the nature of the ganglionic cell in its relation to a certain stimulus; and the reaction or desire becomes the motive of a general action on the part of the individual, for the purpose of satisfying a want or of shunning an ill" (Maudsley). Any of these self-conscious appetites may become the main-spring of a voluntary action. A desire which so results is gradually evolved out of an unconscious organic appetite into an emotion, or a series of intelligently-connected efforts. The physiological relation existing between the sexes is a part of the organic law of reproduction. The action of this law finds its expression through the brain, instinctively or emotionally in desire. This participation of the brain in the reproductive stimulus is an absolute necessity in order to place the sexes in a relation favorable to an observance of one of the laws of their existence. With the gradual

evolution of sex physically there is a corresponding evolution psychically. The one is necessary to the organic part, the other is necessary to the mental part, of reproduction. This development of the possibility of love with structural completion is one of the most striking examples of the evolution of organic life into consciousness. The mental awakening is gradual. Vague and undefined desires exist long before they have taken definite shape in the consciousness; there is a satisfaction, too obscure and gradually evolved to startle the subject into consciousness, in the society of the other sex. These undefined desires become a part of a self-conscious act when one object is selected from the many and is associated with the most sacred emotion—love. In order to prove that this emotion can exist independent of consciousness, and antedate it as it were, it is only necessary to allude to the fact that, in human beings, the instinct attains a knowledge of its aim, and even a sort of satisfaction, in dreams, before it does so in real life. Upon this Dr. Maudsley remarks as follows: "This fact might of itself suffice to teach psychologists how far more fundamental than any conscious mental state is the unconscious mental or cerebral life."

Physiologically, this is the origin of the beautiful emotion called love. In a healthy brain and body, one in which all organic impulses find a reaction in normal consciousness, the emotion of love is allied with all that is pure and noble in the character of the individual. Men find in it an incentive to exertion, and a spur to their ambitions, while women without thought array themselves in all the graces of dress and manner to attract the beloved one. But we can say of love, what Bacon says of it, that "the mind in its own nature would be temperate and staid, if the affections, as winds, did not put it in tumult and perturbation." This may be the effect of love even in its healthy manifestations. In those cases—and they are not rare—in which the organic appetites affect unduly and too persistently the consciousness, it becomes the source of great unhappiness or of bad health. It would be indeed hard to recognize as love the exhibition of this emotion in the depraved. Among this class it is exhibited as love brutalized. Revolting as it is in this form to all that is elevated in our mental character, I yet believe it to be love in its rudimentary form. It is love stripped of its refinements, of its singleness of object, of its purity. It is often said that man is but little lower than the angels; if there is any thing which tends to this imaginary elevation it is this faculty of identifying another with all earthly hopes, of making the happiness and well-being of a fellow-creature the aim and motive of a lifetime. But this same emotion, when it finds expression in these abnormal states of consciousness, allies man to the brute, and tends to show from what depths the present moral and intellectual nature of man was elevated by the slow progress of evolution.

As I have already tried to show that mentally men and women define two opposite types of mind, we shall find strong confirmation

of this by contrasting love as presented in the sexes. As there is no process of vivisection or array of physical facts which will prove this, we must study this emotion as we know it to exist in the mass of men and women, and which has been verified by common experience. But, in the first place, we must bear in mind the widely-diverging paths in life followed by men and women. Men enter the world and labor bodily or mentally, and thus expend all surplus energy. This energy is used at the direct expense of the emotional life. Women, as a rule, do not have this vicarious outlet for the emotions. Love with women exists as an entity, with men as an abstraction. A study of tables of suicidal deaths in both sexes gives us some startling evidence of the difference in both the intensity and effect of this emotion in men and women. The decade between twenty-five and thirty-five years of age affords the largest number of voluntary deaths for women. It is during this period of woman's life that the demand for love is greatest. The functional life is exerting its most potent sway over mind and body. Thus it is that to love and to be loved is a physiological demand during this period, and it becomes evident that this excess of suicides is the outcome partly of a defeated sexual life. The figures for men present a remarkable contrast. The same period in the life of men is also the period of greatest sexual activity. But, whatever vicissitudes the emotion of love among men may be subjected to, it does not find expression in self-destruction. On the contrary, the period of greatest liability to suicides is postponed to the period when the sexual energies have expended their youthful ardor, so that the decade between thirty-five and forty-five years of age gives the greatest number of suicidal deaths, and during which interval it is that the business or worldly interest of men attains success, or ends in failure.

Another fact derived from the same source throws light on this interesting subject. The condition of concubinage almost trebles the number of voluntary deaths for women. It seems reasonable, from what we know of human beings, to assert that it is not the continuance, but the breaking up of these relations—which, in a monogamous state of society, must invariably occur—that leads to this result. We have here almost positive proof that this tendency to self-destruction in the relation of women to the other sex finds its factor in a defeated sexual feeling or love. It is generally understood that the mental and bodily structure and function of women develop at an earlier age than in the other sex. Now, there are twice as many suicides among girls as among boys under the fifteenth year. A leading character of the earlier development of women over the other sex is a sexual one—a capacity to love and to be loved. It is a very significant fact in comparing the degree and quality of love as we find it existing in men and women, that the two periods in woman's life in which suicidal deaths exceed those in the male are at the time of structural completion and greatest functional activity. This demonstrates the predominance of

a capacity to love in woman's psychical nature, and its greater power to impress itself profoundly upon the deliberate acts of her life over that of man. Madame de Staël truly said that "love is the history of woman's life; it is an episode in man's."

Love defeated in the attainment of its object becomes in man an incident to be forgotten, or to be remembered with impatience. A defeated love with woman is too often a defeat of her intellectual life. An emotion, the misdirection or disappointment of which is capable of inducing a large per centum of insane in one sex over the other, must surely differ in degree and kind. Certainly we must credit this excess on the part of women with an important physical factor, aside from that of sex proper—being of a less hardy development than man—but these physical peculiarities permit sex to assert its most potent psychical effect to the degree of shaping the actions or destiny of woman. It will suffice, to illustrate the fact referred to, to take the figures from the report of two asylums for the insane—the Pennsylvania Hospital for the Insane, and the Michigan Asylum. Of 141 insane men and women received into these institutions, whose supposed cause of insanity could be traced to disappointed affections, 84 were women, and 57 were men. These figures are taken from an excess of 454 male over female inmates. Now, the figures, as we gather them from asylum reports, show that women are no more prone to insanity than men. It is natural to conclude that a specific cause leading to this excess of insanity in one sex over the other exists with greater force in one than the other, and not that one sex is less able to bear the operation of the specific cause.

There are many well-known facts in physiology, some of them brought out with remarkable force during the employment of anæsthetics, other facts obtained from a state of organic disease, and others from functional derangements, which tend to prove the sexual origin of love, but which would be out of place in a paper of this character. But there is really no doubt expressed by modern writers on physiology or psychology that this emotion is due to a sexual origin. Proof, such as I have advanced, becomes necessary from the popular scope of this paper, and that I have grouped a series of mental acts, and applied to them the name of sexual cerebration.

I offer, in conclusion, some general facts tending to define a fundamental difference in the mental operations of men and women. M. Quetelet has shown that the propensity to crime existing in a mass of people bears a mathematical ratio, both as to its degree and the sex of the perpetrators, to the total of population year by year. The certainty of this ratio is the result of law, which has its origin in the forces which cement together a mass of men under the name of society. Now, the fixed ratio existing between men and women of the same community, as to the nature and extent of the commission of crime, must be the product of the mental and physical peculiarities of sex.

Thus, the author shows that the propensity to crime in men is about four times as great as in women, in France. Now, while this holds true as to crime in general, it does not as to crime in particular. In poisoning, the proportion is 91 women to 100 men, while in murder by other means the difference falls to 4 in 100. If we define the propensity to crime by the enormity of the offense, we find the ratio of M. Quetelet reduced just one-half, as the crime of parricide gives the ratio of 50 to 100. Contrasting with this last offense the wounding of parents, the ratio falls to 22. As the fact of a wound involves the necessity of a personal encounter, we perceive that women instinctively—if I may use the word—shrink from this; therefore, in estimating the means by which the parricides, so greatly exceeding the ratio of other murders, were accomplished, it is evident that some method peculiar to women entered largely into the crime. Next, taking into consideration two crimes, which may, inferentially, be attributed largely to the motive of revenge in both sexes, we find for that of incendiarism a ratio of 34, and for that of assassination a ratio of but 12 in 100. From this it is evident that the propensity to crime and the degree to which women recoil from publicity in its execution are widely different matters, and are traits which distinguish women from men in the perpetration of crime. So marked is this trait that the author, in analyzing crime in general with reference to sex, says that "their numbers diminish in proportion according to the necessity of the greater publicity before the crime can be perpetrated." There are other facts to be reached in this direction showing the extent to which women's criminal acts are affected by sexual peculiarities. In the two great divisions of crime, that against persons and that against property, we find that the sexes are engaged in almost a constant ratio. This is fixed for a series of years for the first class of crimes as 0.16, and for the second at 0.26. In connection with this is a fact, which reiterates itself with the force of a law. It is found that the proportions of the sexes engaged in the crimes against persons and property represent very nearly the same ratio as that of the strength of the two sexes, 16 to 26. The law which controls the commission of crime by the sexes evidently cannot be reduced to the formula of a difference in the propensity to crime dependent upon the relative morality of men and women, but is governed by mental and physical sexual peculiarities. All these figures relate to four years previous to 1830.[1]

The application of this to the matter under investigation is evident. These various actions, involving more or less of thought and resolve, exhibit a radical difference, both in degree and quality, which must have their factors in mental peculiarities. It cannot be objected that there is simply a fundamental physical basis for this difference, since the mental differences of sex must have their origin in the physi-

[1] "A Treatise on Man," pp. 90–92.

cal differences which constitute sex. The fact that the ratio of the extent to which women perpetrate crimes against property is to crimes against persons the same as the ratio of strength between men and women, proves that her less degree of physical power, which is a sexual property, so affects mental action that her deliberate acts are capable of tabulation, and, contrasted with those of men, show a constant series of differences year by year. Were it otherwise, we would expect that these uniform ratios, which point so unerringly to the workings of a law, would disappear, and in their place we should have tabulated confusion.

We obtained an idea of love differentially as it exists in the sexes by observing the degree to which it affects men and women as a probable cause of insanity. In the same manner I think we can gain a knowledge of the comparative intensity with which emotions and states of consciousness, common to both sexes, exist in intellection, by observing the extent to which they react as a probable cause of mental alienation. For my purpose I shall use Dr. Kirkbride's report for the Pennsylvania Hospital for the Insane. The analysis is based upon the supposed causes of insanity in 6,899 cases. Domestic difficulties are the probable causes of mental disease in 47 men and 86 women. Nearly two to one expresses the difference in intensity in the action of this cause. Fright resulted in insanity in 16 men and 36 women. Grief affected 77 men and 256 women, a difference of more than three to one. Religious excitement acts as the cause in 79 men and 127 women, a difference of sixty-two per cent. Nostalgia, 7 women, and no men. From mental anxiety there are 164 men and 261 women insane. These causes, which present such dissimilarity, have one bond of union; they affect the emotional part of the psychical nature. From this I would not conclude that women are less able to bear the operation of these exciting causes than men; but, that the emotional nature of woman is more largely developed, and thus more exposed to the action of such causes as directly affect it. If I am right in this, we would expect to see in women the emotional forms of insanity developed in excess of the same in men; and this is just what we find. Continuing to analyze the tables of Dr. Kirkbride relating to the same cases as above, we find the number of women to be 3,220, the number of men exceeding them by 459; and yet, there are 1,032 cases of melancholia among the women to 832 in men. Prof. Maudsley defines this form of insanity as "great oppression of the self-feeling, with corresponding gloomy morbid idea."[1]

The emotions, it is evident, are both the main recipients of the cause and the field of its morbid expression. Now, from what we know of the mental and physical constitution of woman, we should expect to find this form of insanity developed in excess of all others at the period of greatest sexual activity, and consequently of greatest

[1] "The Physiology and Pathology of the Mind," p. 320.

emotional sensibility. And here, again, our anticipations are realized by the figures. The interval between twenty and forty years constitutes this period in women. For these ages inclusive we have 1,923 cases of insanity against 1,297 cases for all other ages. It therefore follows that more than one-half the cases of insanity for this period were of melancholia. We can gain a clearer idea of the intensity of emotional activity in women by extending further the same line of comparison in regard to men. For the ages between twenty and forty inclusive we have 2,172 cases of insanity, and but 832 cases of melancholia for all ages. This shows a marked contrast in the liability of the sexes to this form of mental disease; for, at this period, the number of male cases exceeding the female by 200, yet the percentage of melancholia is thirty-three against fifty-three per cent. for women.

I do not believe that I err when I say that this excess in the emotional nature of woman over that of man is the outcome of physical and functional sexual traits, and is, consequently, another phase of sexual cerebration.

The above throws considerable light upon that peculiarity in woman's character so gracefully alluded to by George Eliot, and which I had so much difficulty in defining in the opening part of this article. This gentleness springs from woman's exquisite emotional susceptibility, as it is from the play of the emotions that this character becomes manifest. Having in view its origin in the emotions, and reaching its greatest development at the period of completion in woman's sexual genesis, the evidence of its existence as a form of sexual cerebration becomes complete. Were it otherwise, we would expect to see it obeying laws other than those of sexual development, and not existing in equal intensity during childhood, developed in excess of the male at womanhood, to disappear in the placidity of old age.

I have been using these statistics of insanity for the purpose of showing the extent of normal differences in the mental constitution of the sexes, and consequently of normal sexual cerebration. If we were to consider this in its abnormal phases, we would have opened before us another great field of investigation, the study of which would throw much light upon many problems of sex. Puerperal and gestational mania, the singular perversion of the maternal emotion attending lactation, are of special importance with reference to abnormal sexual cerebration. Hysteria, peculiarly a feminine disease, undoubtedly has its origin in sexual functional derangement, and is a striking example of the extent to which the emotional nature may be perverted by the abnormal actions of certain organs. Those cases of the social evil which break out from the purest domestic surroundings, and which defy all attempts at reform, are evidently due to the perversion of a healthful psychical state. The services of a skilled physician are needed to reform this class, and not the sentimental aid of reform societies, or the visits of the colporteur.

But here we are dealing with the healthy evidence of sex in mind. I have referred to but few of the many recognized intellectual states or processes, and yet they are sufficient to define differentially the average mental conditions of the sexes. With these as a basis of difference, the acuteness of intuitions, the vividness of imagination, and the want of intellectual belligerence, so often spoken of as traits of the feminine mind, and the existence of a modified or opposite form of these in the mental type of the other sex, can, with equal justice, be traced to sexual differences. Sex does not exist simply as a physical state; but we find it pervading organic life, and asserting itself potentially in every mental process. I believe the relation of the sexes in society bears to sexual cerebration the relation of cause and effect. Since the beginning of the historic age, under every variety of mental and physical conditions, the sexes have preserved their moral relations to each other almost unchanged. In what way can this be explained, except as the working of a natural law? There appears to me to be no law so adequate to explain this as that of sexual cerebration.

Several of the reviewers of a former paper seem to have regarded me as the avowed enemy of woman's social and moral advancement. I have entered upon the study of the relations of the sexes to the matters of daily life, with the single purpose of arriving at truth by the use of scientific methods. I believe the field gone over in this and former papers to belong properly to the student of Nature, and not to the so-called social reformer. I cannot bring myself to use the term "woman's sphere;" women have no sphere, except as it is defined by usefulness. I concede to woman the right to essay her fortune in any profession: I simply claim the right to courteously study her in her new relations. The ethnologist cannot be called the enemy of mankind, because he studies the different natural races of men; the botanist cannot be called the enemy of the rose, because he has analyzed its parts, and assigned it its place as a thing of beauty in the scheme of Nature.

THE DEEPER HARMONIES OF SCIENCE AND RELIGION.[1]

II.

I HAVE suggested the thought of a God revealed in Nature, not by any means because such a view of God seems to me satisfactory, or worthy to replace the Christian view, or even as a commencement from which we must rise by logical necessity to the Christian view. I have suggested it because this is the God whom the present age actually does, and in spite of all opposition, certainly will worship, also because

[1] From a series of papers, in *Macmillan's Magazine*, on "Natural Religion."

this aspect of God is common to all theologies, however much in some it may be slighted or depreciated; and, lastly, because I do not believe that any theology can be real or satisfying that does not make it prominent as well as admit it. I can conceive no religion as satisfactory that falls short of Christianity; but, on the other hand, I cannot believe any religion to be healthy that does not start from Nature-worship. It is in the free and instinctive admiration of human beings for the glory of heaven, earth and sea, that religion begins, and I cannot imagine but as morbid a religion which has ceased to admire them.

But many readers will probably think that not much is to be hoped for from dwelling on this subject. "We know very well that the universe is glorious, but, when you have said that, there is an end of the matter. We want to make atheists believe in God, and you do it not by changing their minds, but by changing the meaning of the word God. It is not a verbal controversy that rages between atheists and Christians, but a controversy that concerns the most serious realities. When people display such rancor against religion as was shown by the Paris Commune, you may be sure there is some essential matter in dispute, and that nothing is more vain than to attempt to reconcile them by refining upon words. According to the definition you have given of theism, no rational being could ever be an atheist."

I will endeavor to answer this supposed objection at length, and the part of it which sounds the most formidable will give me the least trouble. That people do not shoot and stab each other for a word is not always true. In fact, when the word is theological that is just what people do. It has often been remarked of theological controversies, that they are never conducted more bitterly than when the difference between the rival doctrines is very small. This is nearly correct, but not quite. If you want to see the true white heat of controversial passion, if you want to see men fling away the very thought of reconciliation, and close in internecine conflict, you should look at controversialists who *do not differ at all*, but who have adopted different words to express the same opinion.

But the other question raised in the objection, the question whether there can be such a thing as atheism, will furnish me with a convenient point from which I may start for a fuller explanation of what I mean by the worship of God in Nature. As I have represented modern science as a form of theism, and as there is no rational man who does not believe—at least, in a general way—in science, it follows of course that no sensible man in these times can be speculatively an atheist. And I believe no one can, however many great philosophers may have congratulated themselves upon accomplishing that feat. If, then, no man could be an atheist practically without being one speculatively also, it would be true that men are entirely mistaken in the importance they attach to the distinction between theist and so-called atheist. It would then appear to be a misdescribed distinction, and to be in reality

only a distinction between two kinds of theists. This is what in common controversy it actually is. One might suppose beforehand that the theist and atheist must necessarily have the whole diameter between them, that their thoughts upon all subjects must be affected by this fundamental difference. It is not so in fact; the theist and the so-called atheist often indeed differ very widely, but sometimes also they think very much alike. This is, in reality, because one or other has been misnamed, for, between a real and thoroughly convinced theist and an atheist really deserving that name, there is almost as much difference as we could expect; only the latter character is not very easy to meet with.

An atheist in the proper sense of the word is not a man who disbelieves in the goodness of God, or in his distinctness from Nature, or in his personality. These disbeliefs may be as serious in their way as atheism, but they are different. Atheism is a disbelief in the existence of God—that is, a disbelief in *any* regularity in the universe to which a man must conform himself under penalties. Such a disbelief, as I have said, is speculatively monstrous, but it may exist practically, and where it does is an evil as fatal to character and virtue as the most timid religionist supposes. We may consider here, briefly, some of the forms which atheism assumes.

The purest form of atheism might be called by the general name of *willfulness*. All human activity is a transaction with Nature. It is the arrangement of a compromise between what we want on the one hand and what Nature has decreed on the other. Something of our own wishes we have almost always to give up; but by carefully considering the power outside ourselves, the necessity that conditions all our actions, we may make better terms than we could otherwise, and reduce to a minimum what we are obliged to renounce. Now we may either underrate or overrate the force of our own wills. The first is the extravagance of theism; it is that fatalism which steals so naturally upon those who have dwelt much upon the thought of God, which is said to paralyze, for example, the whole soul of the Mussulman. But the opposite mistake is a deficiency of theism; a touch of it often marks the hero, but the fullness of it is that kind of blind infatuation which poets have represented under the image of the giants that tried to storm heaven. Not to recognize any thing but your own will, to fancy every thing within your reach if you only will strongly enough, to acknowledge no superior power outside yourself which must be considered and in some way propitiated if you would succeed in any undertaking—this is complete willfulness, or, in other words, pure atheism. It may also be called childishness, for the child naturally discovers the force within it sooner than the resisting necessity outside. Not without a few falls in the wrestle with Nature do we learn the limits of our own power and the pitiless immensity of the power that is not ours. But there are many who cannot learn this lesson even

from experience, who forget every defeat they suffer, and always refuse to see any power in the universe but their own wills. Sometimes, indeed, they discover their mistake too late. Many barbarous races are in this condition. In their childishness they have engaged themselves in a direct conflict with Nature. Instead of negotiating with her, they have declared a blind war. They have adopted habits which they gradually discover to be leading them to destruction; but they discover it too late and when they are too deeply compromised. Then we see the despair of the atheistic nation, and its wild struggles as it feels itself caught in the whirlpool; then, a little later, we find that no such nation exists, and on the map its seat begins to be covered with names belonging to another language. Less extreme and unredeemed, the same Titanism may sometimes be remarked in races called civilized. Races might be named that are undergoing punishments little less severe for this insensate atheism. "Sedet æternumque sedebit," that unhappy Poland, not indeed extinguished but partitioned, and every thirty years decimated anew. She expiates the crime of atheistic willfulness, the fatal pleasure of unbounded individual liberty, which rose up against the very nature of things. And other nations we know that expect all successes from the mere blind fury of willing, that declare the word impossible unknown to their language. They color their infatuation sometimes with the name of self-sacrifice, and fancy they can change the Divine laws by offering up themselves as victims to their own vanity; they "fling themselves against the bars of fate;" they die in theatrical attitudes, and little know how "the abyss is wreathed in scorn" of such cheap martyrdom.

A wrong belief about God, however fatal it may be, is not atheism. Mr. Buckle tried to show that the Spanish empire fell through a false conception of the order of the universe; and it seems clear that the rigid Catholic view of the world is dangerous in this age to every nation that adopts it. These are the effects of false theology. But there is a state of mind which, though very far removed from the willfulness I have been describing, and often accompanied with a strong and anxious religiousness, may nevertheless be practically regarded as a form of atheism. It is the state of those minds which, fully believing in an order of the universe, yet have such a poor and paltry conception of it that they might almost as well have none at all.

People are sometimes led to this by a very reasonable and excusable process of thought. Naturally modest and distrustful of their own powers, they despair of understanding the order of the universe; they think it almost presumptuous to attempt to understand it. Wisely distrustful of any knowledge that is not precise, they avert their eyes instinctively from every thing which cannot be made the subject of such knowledge. In all their transactions with Nature, to use my former phrase, they make it a rule to be unambitious. They aim at objects very definite and very near. Whatever they gain they

make it a rule not to expose to any further risk. They avoid, as it were, meeting the universe in front, and endeavor to overcome it in detail. For its immediate purpose this plan is the best that can be pursued. If in all our actions we allowed ourselves to remember the greatness of the power with which we have to do, we should accomplish nothing; if, because Nature's laws are large and comprehensive, we never acted except on the largest principles, we should either fall a prey to unsound generalizations, the more ruinous because of their grandeur, or we should become paralyzed with a Turkish fatalism. Far better, no doubt, it is to make the utmost use of what precise knowledge we have, however little may be the amount of it, and not to suffer our minds to be bewildered by coping too freely with an adversary whose play is beyond us. It is these humble, cautiously inductive people that prosper most in the world up to a certain point. To them belong the large populations, the thriving communities, the stable politics. They never dream of defying Nature; they win an endless series of small victories over her.

There is no reason why this cautiousness should necessarily degenerate into little-mindedness. It does not take its beginning in any deficiency in the feeling for what is great. On the contrary, it is the direct result of an overwhelming sense of the greatness and, so to speak, the dangerousness of Nature. Those who proceed thus warily, probing Nature as they go, may with most reason expect to penetrate far and to elevate their minds gradually until they can venture to cope with the grandeur of the world and become familiar with great ideas. And when this is done they will have escaped the danger of atheism. Their minds will become the mirror of an Infinite Being, and their whole natures will be conformed to his. But in the earlier stages of such a process the temptation to a kind of atheism is strong. From the habit of leaving out of account all larger considerations in every problem, on the ground that they are vague and not precisely calculable, they are led easily to forget the very existence of such considerations. In some cases this habit even leads to great practical miscalculations. It is evidently a mistake in algebra to assume that all unknown quantities $= 0$; yet this mistake is constantly made by the practical men I am describing. When vague considerations are suggested to them, instead of assigning them an approximate value, which, since they cannot get the true value, is evidently what they ought to do, they leave them out of account altogether, though an indeterminate value may just as easily be large as small. But it is not with these practical mistakes that I am now concerned; practically these men are more often right than wrong, though in the exceptional cases, when every thing turns on a great principle, they fail deplorably. But the habit of never suffering the mind to dwell on any thing great produces often an atheism of the most pitiable and helpless kind. The soul of man lives upon the contemplation of laws or principles;

it is made to be constantly assimilating such sustenance from the universe; this is its food: *not by bread only, but by every word that proceedeth out of the mouth of God, doth man live.* What, then, must be the moral starvation of the man who, from an excess of caution, turns away from every thing of the kind, until from want of habit he can no longer see such things, and forgets their very existence; so that for him there is no longer any glory in the universe! For all beauty or glory is but the presence of law; and the universe to him has ceased to be a scene of law, and has become an infinite litter of detail, a rubbish-heap of confused particulars, a mere worry and weariness to the imagination. I have been describing the Philistine, the miserable slave of details, who worships a humiliated, dissected and abject deity, a mere Dagon, "fallen flat upon the grundsel-edge, and shaming his worshipers."

There is a particular form of conventionalism which all men who see it instinctively call by the name of atheism. By conventionalism generally, I understand the mistaking of institutions, usages, forms of society, which essentially are temporary and transitory, for normal and permanent forms. It is conventionalism, for example, when hereditary royalty or aristocracy are supposed to be not merely good institutions in particular cases but necessary in all countries and times. There is nothing at all atheistic in such a mistake; it is rather a superstition—that is, it is a false belief, but still a belief. The temporary arrangements are honestly confused with eternal laws, the feelings and views which in course of time have grown up around them are honestly mistaken for essential morality. The devoted adherents of the exiled Stuarts and Bourbons, the early Jesuits and the other champions of the counter-reformation, seem to me to have been such conventionalists. I think they confounded a transitory state of things with the sacred and eternal laws of human society. But for a long time their faith was genuine though mistaken. They had a God, and therefore they had vigor, and occasionally victory. But at the same time their belief was an ebbing tide. The movement of the age was, on the whole, against it; their successes always bore the marks of being accidental, and were followed in no long time by more than equivalent reverses. They could never give a character of reality to what they created; they could seldom feel quite easy and happy in their party strife. Their eloquence was copious and sonorous, but not often quite natural, and seldom convincing or overwhelming. And with such conventionalists, when the age puts them on their defense, these misgivings, this uneasiness, this constraint and depression go on increasing. Doubt penetrates them in spite of all their resistance, in spite of all the chivalrous devotion to their cause upon which they pride themselves. In the ardor of conflict they have pushed into the foreground all the weakest parts of their creed, and have got into the habit of asserting most vehemently just what they doubt most, be-

cause it is what is most denied. As their own belief ebbs away from them, they are precluded from learning a new one, because they are too deeply pledged, have promised too much, asseverated too much, and involved too many others with themselves. Thus their language becomes more and more vehement and hollow, more and more despairing under the mask of triumphant confidence. It may happen that the cause they defend is not merely unsound, but terribly bad, that what they have taken for sacred institutions are in reality monstrous abuses. Then, as they become reluctantly enlightened, as their advocacy grows first a little forced, then by degrees consciously hypocritical, until in the end their eyes are fully opened not only to the fact that their cause is bad, but, to all the enormous badness of it, there follows a complete moral dissolution of the whole man. Unable to abandon a position he is bound to, forced to act belief and enthusiasm when under the mask there is the very opposite of both—settled disbelief and utter disapproval—the man sees now in the universe nothing but a chaos. At the beginning he had a God; his actions were regulated by a law which he recognized in the universe; but now he recognizes this law no more, and yet is forbidden by his situation from recognizing any other. The link that bound him to the universe is snapped; the motive that inspired his actions is gone, and his actions have become meaningless, mechanical, galvanic. He is an atheist, a man without a God because without a law. Such men may generally be noted among the most intelligent adherents of expiring causes, demoralized soldiers, powerless for good and capable of any mischief.

These are specimens of what seems to me to be properly called atheism. The common characteristic of all these states of mind is feebleness. In the first example you have violent feebleness, impotence; in the second, cautious feebleness; in the third, cynical feebleness; but in all cases feebleness springing from a conscious want of any clew to the order of the universe. The specimens I have selected are all such as may be furnished by men of great natural vigor. The cynical atheist has often an extreme subtilty of intellect, the Philistine commonly begins with a great grasp of reality, a great superiority to illusions; the willful atheist has often much imagination and energy. Where a character wanting in energy is infected by atheism, you have those *αμένηνα κάρηνα* of which the world is at all times full. By the side of the profound cynic you have the mere lounger, who can take an interest in nothing, all whose thoughts are hearsays, never verified, never realized, not believed, not worthy of the name of prejudices—echoes of prejudices, imitations of hypocrisy. He moves about embarrassed and paralyzed by the hollowness of all he knows; conscious that nothing that he has in his mind would bear the smallest criticism or probation, knowing no way to any thing better, and meanwhile ingenuously confessing his own inanity. By the side of the over-judicious Philistine, who has fallen into feebleness through an excessive dread of general-

izing hastily, there may be seen the born Philistine, who does not know, and has never heard, what generalizing is, who becomes uncomfortable when he hears a principle enunciated, as if he had been addressed by a foreigner in some language unknown to him, and whose homely talk never willingly travels beyond what time the train starts, and whether it happened on Monday or on Tuesday. Lastly, by the side of the brilliant Utopian, who overlooks the greatness of the necessity with which he has to contend, there is the Utopian without brilliancy, the *enragé*, the mere restless disturber.

As atheism is but another name for feebleness, so the universal characteristic of theology—if we put aside for the present the rare belief in an utterly hostile or thwarting Deity—is energy. He who has a faith, we know well, is twice himself. The world, the conventional or temporary order of things, goes down before the weapons of faith, before the energy of those who have a glimpse, or only think they have a glimpse, of the eternal or normal order of things. And this vigor of theism does not much depend on the nature of the God in whom the theist believes. Just as atheism does not consist in a bad theory of the universe, but in the want of any theory, so theism consists not in possessing a meritorious or true or consoling theory, but simply in possessing a theory of the universe. He who has such a theory acts with confidence and decision, he who has no such theory is paralyzed. One of the rudest of all theories of the universe is that propounded by Mohammed, yet it raised up a feeble and dispersed nation to vigor, union, and empire. Calvinism presents assuredly a view of the universe which is not in any way consoling, yet this creed too gave vigor and heroism. The creed of the earliest Romans rested upon no basis which could for a moment pass for philosophical, yet while it was believed it gave order to the state, sanction to morality, victory to the armies. Whatever kind of theology be in question, so long as it is truly believed, the only danger is of its inspiring too much energy—of its absorbing its votaries too much, and driving them into extreme courses.

And so if the Nature recognized by Science be not benevolent, and have provided no future life for men, it does not follow that her votaries are not theologians, and it is quite clear that their theology gives them energy. Many theologies have had no future life; indeed, it is well known that our own, in its earlier Judaic form, laid no stress upon any future life. And it is not the benevolence of his Deity which gives so much energy and confidence to the convinced theist; it is rather the assurance that he has the secret of propitiating his Deity. It was not because Jupiter and Mars were benevolent beings that the Roman went out to battle confiding in their protection. It was because all sacrifices had been performed which the pontiffs or the Sibylline books prescribed. Just of the same kind is the theistic vigor which we see in modern science. Science also has its *procuratio*

prodigiorum. It does not believe that Nature is benevolent, and yet it has all the confidence of Mohammedans or Crusaders. This is because it believes it understands the laws of Nature, and knows how to deal so that Nature shall favor its operations. Not by the Sibylline books, but by experiment; not by supplications, but by scientific precautions and operations, it discovers and propitiates the mind of its Deity.

But by the side of this scientific theology decrying theology there is also a popular outcry against theology. The Revolution in Europe delights in declaring itself atheistic. The meaning of this in the main is, that it wishes to express in the tersest possible way its hatred of the reigning theology. But with this feeling there is no doubt a mixture of that real atheism I have described above under the name of willfulness. These revolutionists have so little conception of the greatness of the powers which determine the order of things, that they imagine they have only to make up their minds and to express their resolution with sufficient vehemence and to fling away their lives with sufficient recklessness, and human society will in a short time assume just the shape they wish. They think, in short, that they themselves are very great, and that Nature is very little. Still, it is evident enough that their hatred against the reigning theology is not a merely capricious feeling. It is no wild, egotistic grudge against whatever is powerful, however this feeling may occasionally blend with it. It is a serious, persistent, deep-rooted aversion. But it by no means follows that the reigning system excites their hatred purely as a theology, even though they themselves believe so. In their furious invectives against God, nothing is more evident than that they are thinking of a special conception of God, and, though they themselves do not profess to substitute any other conception, it is very possible they are unconsciously doing so. At any rate, the mere fact that these men are nominally atheists proves no more than is proved by the same name having been commonly bestowed upon the first Christians.

What, then, are the grounds of the irreconcilable repugnance of the Revolution for theology? Nothing is more easy than to distinguish and enumerate the principal ones. First may be ranked the political ground, that is, the intimate connection in which they find theology standing to the political system they are laboring to overthrow. Twice in modern Europe it has been possible to discern the interdependence of the reigning political with the reigning theological system. Modern history is filled with two great movements, the Reformation and the Revolution. The first was an attempt to purify religion, the second an attempt to reform government and society. In both cases the principal obstacle to the movement was found in the coalition of the Church and Government. The decided reaction against the Reformation which marks the second half of the sixteenth century, and which ended in restoring the mediæval form of Chris-

tianity in so many countries of Europe, seems to have been principally caused by the feeling of some courts, particularly the imperial court, that they could not afford to forfeit the support of the great Catholic organization, and by the corresponding disposition in Catholicism to ally itself with governments. The principle of saving the Church by the help of governments was avowed—Ranke tells us—by Pope Pius IV., and it was by this means that Catholicism was restored upon a new and strengthened foundation at the Council of Trent. What the Church owed to the state for protection against the Reformation it repaid two centuries later in assistance against the Revolution. A time had come round when the state was threatened as the Church had been, and now kings became faithful churchmen as the churchmen of Pius IV.'s school had before become faithful royalists. For half a century kings had coquetted with free-thought, and free-thought had flattered kings. But when the crisis came, and royalty was in danger, it hurried back to find shelter in the Church. Napoleon, Charles X., and the Emperor Francis, formed the new alliance by which theology was called in to drive out revolution in the state, just as Pius IV. formed the older alliance with royalty against Reformation in the Church. The natural effect of this coalition is to incline the Revolution to attack the Church at the same time that it assails Government. Atheism has become the creed of revolution because theology has been the traditional creed of monarchy and of privilege.

But is it true that theology is necessarily conservative or monarchical, because it happens to be true of the Christian Church, or the most prominent part of it, at this particular time? At particular times and places theology has been revolutionary. The earliest Christians must have seemed the most revolutionary party of the Greek and Roman world. Mohammedanism was so violently revolutionary that it completely transformed the Eastern world, and has caused almost the whole East to look back upon the ages preceding it as upon "times of ignorance." The same may be said of Buddhism in Asia. And certainly one form at least of Protestantism—I mean Puritanism—was revolutionary in spirit, and led either to an abridgment of royal power or to positive republicanism.

Hereditary royalty and aristocratic privilege were the institutions which, in the last century, the Revolution attacked. It was historically in the names of skepticism, and sometimes of atheism, that the attack was conducted. But there was no reason at all in the nature of things why the same attack should not have been made in the name of theology. In France, theology has been on the side of privilege, and equality has been associated with opposition to theology. But, in Turkey the opposite has happened; the equality of mankind has been preached, and successfully, in the name of theology. If a Christian preacher had been inspired to do so, he might with perfect warrant from his religion have proclaimed equality in France. Indeed,

this was to some extent what actually happened. Rousseau spoke partly in the name of theology, and even of Christian theology; and it was not until the skeptical foundation had been in a manner abandoned, and an appeal made to religion, that the spirit of political change awoke.

Indeed, to say that the Revolution has charged upon theology itself what is merely the defect of a particular theology, is a statement much short of the truth. The conservatism of the Church in the last ages is not principally due to the natural tendencies of the Christian religion. It is not so much Christianity as the Church that has been conservative. Church and government have been drawn together not so much from any natural sympathy—witness their perpetual conflicts in the middle ages—as by a common danger. All that can be said is, that in the hour of difficulty, when it was their obvious interest to combine, they have not found themselves so antipathetic that they could not do so. In neither of the two great crises was the help rendered by the one to the other disinterested. In the sixteenth century it was the Church that was threatened most; but governments were also uneasy, and took as well as gave in the arrangement they made with the Church. In the Revolution the state struggled for life, but the distress of the Church was almost as great. In these circumstances they would be driven into alliance even in the absence of any natural affinity, and being once in alliance would excite the indiscriminate aversion of the Revolution as if they had been natural allies. In one instance at least this has been strikingly realized. When the Revolution attacked monarchy and privilege, it was not very surprising that they should attack Christianity at the same time. Christianity is entirely silent on the question of liberty, and lends no support to those who contend against despotism. It has been used to defend despotism, and not without plausibility. It is not quite the same with privilege. Christianity is clearly favorable on the whole to equality, and yet even here its declaration is not very distinct. But in due time the Revolution, having conquered these enemies, went on to attack new ones. Leaving behind its mediæval monarchy and aristocracy, it proclaimed war against plutocracy. It proclaimed the principle of fraternity, fraternity between individuals as opposed to reckless competition in industry, fraternity between nations as opposed to war. Now, this new principle is not merely consistent with Christianity; to say this would be almost as absurd as to call it inconsistent with Christianity. It is neither more nor less than Christianity itself. Christianity is certainly not a socialistic system, because it is not, in that sense of the word, a system at all, but most assuredly Christianity furnished the ideas which the different socialistic systems are blundering attempts to realize. Not only so, but I believe that Christianity as a morality actually did nothing else, and that the modern word fraternity coincides exactly with the

moral side of Christianity. And when fraternity was first put upon the order of the day in 1848, this fact was to some extent recognized. Christianity actually played a certain part in that Revolution. But then followed a restoration of the old alliance between the Church and Government. For twenty years they continued accomplices in reaction. The consequence has been that when Revolution once more raises its head, it is no longer able to see the identity of fraternity and Christianity, nay, absolutely identifies Christianity with the negation of fraternity. How far it is possible to falsify an institution was never known to mankind until, in 1871, the Paris workmen assailed with irreconcilable fury the Church of Christ in the name of human brotherhood.

Thus the political repugnance of the Revolution to theology is in part merely a repugnance to an institution which has falsified the theology of which it is the depositary, and in any case is a repugnance not to theology as such, but merely to a particular theology. But the Revolution has also, no doubt, a quarrel with theology as a doctrine. "Theology," it says, "even if not exactly opposed to social improvement, is a superstition, and as such allied to ignorance and conservatism. Granting that its precepts are good, it enforces them by legends and fictitious stories which can only influence the uneducated; and, therefore, in order to preserve its influence, it must needs oppose education. Nor are these stories a mere excrescence of theology, but theology itself. For theology is neither more nor less than a doctrine of the supernatural. It proclaims a power behind Nature which occasionally interferes with natural laws. It proclaims another world quite different from this in which we live, a world into which what is called the soul is believed to pass at death. It believes, in short, in a number of things which students of Nature know nothing about, and which science puts aside either with respect or with contempt." Now, these supernatural doctrines are not merely a part of theology, still less separable from theology, but theology consists exclusively of them. Take away the supernatural person, miracles, and the spiritual world, you take away theology at the same time, and nothing is left but simple Nature and simple science. Thus theology comes to be used in the sense of supernaturalism, and in this view also excites the hostility of the age. Not merely scientific men themselves, for of these I am not now speaking, but liberals in general, all those who have any tincture of science, all whose minds have in any degree taken the scientific stamp, a vast number already, and, as education spreads, likely to become coextensive with civilized mankind, form a habit of thought with which they are led to consider theology irreconcilable.

It is a singular coincidence which has combined in apparent opposition to theology the two mightiest forces of the present age. Truly it is not against flesh and blood that Religion has to contend,

but against principalities and powers, that is, against the Revolution and against Science. Hasty minds, poetic imaginations, ready theorists, will never be content to see a mere coincidence in this. They will not admit that theology has been undeservedly charged with all the sins of that ancient corporation called the Christian Church, with which sins in reality it had nothing whatever to do. It is much more convenient to imagine the Church as the body of which theology is the soul, and to trace all the body's actions to the natural disposition of the informing soul. By this easy process we arrive at the conclusion that theology is an essentially conservative and stagnant principle, with the strongest natural affinity for despotism, privilege, respectability, and every kind of antiquated pretension; that, in short, it is a way of viewing the universe which inevitably leads to all the vices peculiar to old endowed corporations. And that an institution which is opposed to the Revolution should be at the same time at war with Science will never be thought a mere coincidence. Party spirit will be adroit enough to make it out that Science and Revolution are as soul and body on the one side, as theology and conservatism are on the other; that people who believe in miracles must necessarily side with capital against labor, and that large standing armies follow logically from a belief in benevolent design.

As to the mistake which lies in confounding theology with supernaturalism it is not necessary here to do more than repeat shortly what was said in the first chapter. First, then, there is no necessary connection between theology and supernaturalism. It is quite possible to believe in a God, and even a personal God, of whom Nature is the complete and only manifestation. Supernaturalism is part of the reigning theology, but it is not any necessary part of theology, as such. Secondly, when it is said that supernaturalism is *identical* with theology, this is not true at all, even of the reigning theology, i. e., of modern Christianity. Such a notion has sprung from a confusion of ideas. In the controversy between Christianity and Science it has become usual for shortness to give the name of theology (meaning Christianity) to that part of theology which science controverts. This is a very usual and, if rightly understood, a very harmless controversial practice. The agreements between theology and Science may very properly be overlooked by controversy which is only concerned with their differences. But it is the mistake constantly made by controversialists to adopt this abridged notation, as I might call it, outside the domain of controversy. For example, Catholicism means two quite different things according as the word is used in controversy or not. In controversy with Protestantism, Catholicism means worship of the Virgin and the saints, transubstantiation, purgatory. But no mistake could be more monstrous than to suppose that if all these doctrines were removed Catholicism would disappear. On the contrary, by far the larger half would remain—worship of God, worship

of Christ, heaven and hell, forgiveness of sins, the law of love. In the same way, in controversy with Science, Christianity (not theology) and supernaturalism are convertible terms. That is to say, if supernaturalism is refuted, Science wins and Christianity loses in the particular controversy in which they are engaged. In the controversial sense this is the destruction of Christianity, but only in the controversial sense. For when the worship of God outside Nature is taken away, the worship of God in Nature remains. Whether this residue is important or unimportant will be considered later; at any rate, it is there; and we may say at once that it would not be surprising if it should turn out more considerable than controversialists believe, when we remember how habitual it is for controversialists to exaggerate their differences, and generally how prodigiously exaggerated is the common estimate of the province of debate and dispute in human affairs.

At any rate, it is evident that the theology of the book of Job, of many of the Psalms, e. g., the 104th, of many passages in the Prophets, of many discourses of Christ, of many passages in the Epistles, would remain unaffected if supernaturalism were entirely abandoned. I will say no more at this stage.

On the whole, then, when we look at the great controversy of the age, what do we see? It is said that a furious attack upon theology is being made by the two distinct though allied hosts of Science and Revolution. But we see something essentially different. We see that what is called Science is indeed a most formidable power, against whomsoever she may declare war, but that her enemy is not theology, but supernaturalism, and that Science herself has all the character of a theology, not comforting or elevating like that she opposes, but not less capable of inspiring zeal and subduing the mind with conviction, and bearing in her hand a budget of practical reforms; and, moreover, that the Deity of her devotion is not different, but only a too much disregarded aspect of the Deity of Christians. The host of Revolution which we see approaching from another side is far less formidable. It is infuriated, but neither knows what it would overthrow nor what it would build. But we can see that its enemy is not theology at all, nor even supernaturalism, except in a secondary degree. It is enraged against an ancient corporation, which, having something mediæval in its constitution, like so many other corporations, has been led in the latest centuries to make common cause with other mediæval institutions which were endangered by the modern spirit. This corporation happens to be the depositary of a theology partly supernaturalistic, but we can see plainly that had it been the depositary of modern science itself it would have excited just the same animosity, nay, probably very much more, for in fact its creed in some aspects is in most remarkable agreement with the revolutionary creed itself.

The result, then, is this—of atheism, that demoralizing palsy of

human nature, which consists in the inability to discern in the universe any law by which human life may be guided, there is in the present age less danger than ever, and it is daily made more and more impossible by science itself: of revolt against the Christian law of fraternity, there is also less than ever in this age, and that redemption of the poor and that pacification of nations which Christianity first suggested are more prominent than ever among the aspirations of mankind. On the other hand, the organization of the Church seems ill-adapted to the age, and seems to expose it to the greatest danger; and, what is far more serious, the old elevating communion with God, which Christianity introduced, appears to be threatened by the new scientific theology, which, while presenting to us deeper views than ever of his infinite and awful greatness, and more fascinating views than ever of his eternal beauty and glory, denies for the present to him that human tenderness, justice, and benevolence, which Christ taught us to see in him.—*Macmillan's Magazine.*

THE BIOGRAPHY OF A BIRD.

By ERNEST INGERSOLL.

THE bird which is the subject of this sketch is familiar to all who walk in green pastures and beside still waters; for in such haunts do the *Bank-Swallows* congregate in merry companies, making up for their want of companionship with man, which is so characteristic of the other hirundines, by a large sociability among themselves. Conservator of ancient ways, it is almost the only swallow which has not attached itself to humanity as soon as it had opportunity, and changed from a savage to a civilized bird. Perhaps it, too, has tried it, long ago, and voluntarily returned to the fields; for our bank-swallow is a cosmopolite, and has watched the rise and fall of all the dynasties and nationalities that have grouped the centuries into eras, from Nineveh to San Francisco. It is at present an inhabitant of all Europe and eastward to China; of a large part of Africa, especially in winter; and throughout North America, the West Indies, Central America, and the northern Andean countries. On both continents its wanderings extend to the extreme north, where, in Alaska, it is one of the commonest summer visitors. So this modest little bird, smallest of his kind, is entitled to our respect as a traveler at least; and, to compare the habits and appearance of the representatives in different portions of the globe of so widely distributed a species, becomes a most interesting study.

Cotyle riparia, the bank-swallow, sand-martin, sand-swallow, river-swallow, *l'hirondelle de rivage*, or back-svala, is generally diffused over

the Northern Hemisphere though very unequally, avoiding those spots unfavorable to them. In this distribution they seem to have been somewhat influenced by man, though owing him no other favors than the incidental help of railroad-cuttings and sand-pits which have increased the sites suitable for their nests and enabled them to spread inland.

It is one of the earliest birds to arrive in the spring, appearing in Old England during the last week in March, and in New England early in May, many passing on to the shores of the Arctic Ocean, where Richardson, at the mouth of the Mackenzie, and Dall, on the Yukon, found them breeding in immense numbers. In these high latitudes its summer is necessarily a brief one, and September finds them back again picking up their congeners for company on the southward journey.

Where these and other swallows spend the winter was a hotly-debated question among ornithologists at the beginning of the present century; some affirming that they migrated with the sun, while others, believing it impossible that such small and delicate birds could endure the great fatigue and temperatures incident to such a migra-

tion, held that they regularly hibernated, during the cold weather, sinking into the mud at the bottom of ponds, like frogs, or curling up in deep, warm crannies, like bats, and remaining torpid until revived by the warmth of spring. Of this latter opinion was White, of Selborne, who alludes to it again and again, and Sir Thomas Forster wrote a "Monograph of British Swallows," apparently with no other object than to present the arguments for and against the theory of their annual submersion and torpidity. One of the difficulties which the *submersionists* put in the way of the *migrationists* was the frequent accidental and isolated appearance of the swallow before its usual time—a fact which has occasioned a proverb in almost every language. The French have, "*Une hirondelle ne fait pas le printemps;*" the Germans, "*Eine Schwalbe macht keinen Frühling;*" the Dutch, "*Een zwaluw maak geen zomer;*" the Italians, "*Una rodine non fa primavera;*" the Swedes, "*En svala gor ingen sommar;*" which all mean, *One swallow doth not make a summer.* The story is well known of a thin brass plate having been fixed on a swallow with this inscription: "Prithee, swallow, whither goest thou in winter?" The bird returned next spring with the answer subjoined: "To Anthony, of Athens. Why dost thou inquire?"

Out of this controversy, evidence of their sudden autumnal adjournment to Africa accumulated in England. Wilson, in this country, showed that their advance could be traced in the spring from New Orleans to Lake Superior and back again, and their regular migration soon came to be acknowledged. Then attention was turned to the season, manner and limits of their migrations, and it was found that, taking advantage of favorable winds, immense flocks of swallows—and many other birds of passage as well—flying very high, passed each fall from the coast of England to the coast of Africa, and from Continental Europe across the Mediterranean direct, whence they spread southward almost to the Cape of Good Hope. No sooner had the spring fairly opened than they were suddenly back again, very much exhausted at first with their long-sustained effort, but speedily recuperated and "diligent in business." Our own migrants, as I have mentioned, winter in Central America and the West Indies, or still farther south.

Their flight is rapid, but unsteady, "with odd jerks and vacillations not unlike the motions of a butterfly," as White describes it; and continues: "Doubtless the flight of all hirundines is influenced by and adapted to the peculiar sort of insects which furnish their food. Hence it would be worth inquiry to examine what particular genus of insects affords the principal food of each respective species of swallow." They are constantly on the wing, skimming low over land and loch, pausing not even to drink or bathe, but simply dropping into some limpid lake as they sweep by to sip a taste of water, or cleanse their dirty coats. It seems strange, then, that birds who sustain the

unremitting exertion of a flight scarcely less than 100 miles an hour in speed, during the whole of a long summer's day, should not be thought capable of the transition from England to Africa. However, at that time it was not well understood what long-continued flight small birds actually do make, as, for instance, from our coast to the Bahamas, or even across to Ireland, or from Egypt to Heligoland, 1,200 miles, which is passed over at a single flight by a certain tiny warbler, in every migration.

The bank-swallow is not a musical bird—a faint, squeaking chirrup being all its voice can accomplish. Nor is it a handsome bird, simply sooty-brown above, white beneath, with a brown breast. To its grace of motion, and charming home-life, we attribute that in it which attracts us so much.

Although probably the least numerous of all the swallows, they do not seem so, because of the great companies which are to be seen together wherever they are to be found at all; and because, leading a more sequestered life, they are not usually brought into direct comparison with house-martins and chimney-swifts. Eminently social in their habits, they congregate not only at the time of migration (then, indeed, least of all), and in the construction of their homes, but sometimes alight in great flocks on the reeds by the river-side and on the beach, where Sir William Jardine saw them "partly resting and washing, and partly feeding on a small fly, which was very abundant." Yet you will occasionally notice stray individuals associating with other swallows.

The secret of the local distribution of the bank-swallows lies in the presence or absence of vertical exposures of soil suitable for them to penetrate for the burrows, at the inner end of which the nest is placed. Firm sand, with no admixture of pebbles, is preferred, and in such an exposure, be it sea-shore, river-bank, sand-pit, or railway-cutting, the face will be fairly honey-combed with burrows, so that we can readily believe that Mr. Dall counted over 700 holes in one bluff in Alaska. These are usually very close together, and the wonder is how the birds can distinguish their own doors. If mistakes do occur, I imagine they are very polite about it, for I know of no more peaceable bird than they. The mode in which this perforation, requiring an amount of labor rare among birds, is performed, is well described by Mr. Rennie, in his "Architecture of Birds:"

"The beak is hard and sharp, and admirably adapted for digging; it is small, we admit, but its shortness adds to its strength, and the bird works . . . . with its bill shut. This fact our readers may verify by observing their operations early in the morning through an opera-glass, when they begin in the spring to form their excavations. In this way we have seen one of these birds cling with its sharp claws to the face of a sand-bank, and peg in its bill as a miner would his pickaxe, till it had loosened a considerable portion of the hard sand, and tumbled it down among the rubbish below. In these preliminary operations it never makes use of its claws for digging; indeed, it is impossible that it could, for

they are indispensable in maintaining its position, at least when it is beginning its hole. We have further remarked that some of these martins' holes are nearly as circular as if they had been planned out with a pair of compasses, while others are more irregular in form; but this seems to depend more on the sand crumbling away than upon any deficiency in its original workmanship. The bird, in fact, always uses its own body to determine the proportions of the gallery—the part from the thigh to the head forming the radius of the circle. It does not trace this out as we should do, by fixing a point for the centre around which to draw the circumference: on the contrary, it perches on the circumference with its claws, and works with its bill from the centre outward; . . . the bird consequently assumes all positions while at work in the interior, hanging from the roof of the gallery with its back downward, as often as standing on the floor. We have more than once, indeed, seen a bank martin wheeling slowly round in this manner on the face of a sand-bank when it was just breaking ground to begin its gallery.

"This manner of working, however, from the circumference to the centre unavoidably leads to irregularities in the direction. . . . Accordingly, all the galleries are found to be more or less tortuous to their termination, which is at the depth of from two to three feet, where a bed of loose hay and a few of the smaller breast-feathers of geese, ducks, or fowls, is spread with little art for the reception of the four to six white eggs. It may not be unimportant to remark, also, that it always scrapes out with its feet the sand detached by the bill; but so carefully is this performed that it never scratches up the unmined sand, or disturbs the plane of the floor, which rather slopes upward, and of course the lodgment of rain is thereby prevented."

Sometimes the nest is carried to a far greater depth than two or three feet, as in a case observed by Mr. Fowler, in Beverly, Massachusetts, where, in order to get free of a stony soil where pebbles might be dislodged and crush the eggs, the tunnel was carried in nine feet, while neighboring birds in better soil only went a third as far. In one place the burrows will be close to the top of the bluff, in another near the bottom, according as fancy dictates, or the birds have reason to fear this or that enemy. English writers agree that occasionally their bank-swallows do not dig holes, but lay in the crannies of old walls, and in hollows of trees. This is never done, that I am aware of, in the United States; but in California a closely allied species, the rough-winged swallow, "sometimes resorts to natural clefts in the banks or adobe buildings, and occasionally to knot-holes." On the great Plains, however, our *Cotylé* burrows in the slight embankments thrown up for a railway-bed, in lieu of a better place.

"How long does it take the bird to dig his cavern under ordinary circumstances?" is a question which it would seem hard to answer, considering the cryptic character of his work. Mr. W. H. Dall says four days suffice to excavate the nest. Mr. Morris, a close observer of British birds, says, *per contra*, that a fortnight is required, and that the bird removes twenty ounces of sand a day. Male and female alternate in the labor of digging, and in the duties of incubation.

When the female is sitting, you may thrust your arm in and grasp

her, and, notwithstanding the noise and violence attending the enlargement of the aperture of her nest-hole, she will sit resolutely on, and allow herself to be taken in the hand with scarcely a struggle or sign of resistance—even of life, sometimes. The young are fed with the large insects which the parents catch, particularly those sub-aquatic sorts which hover near the surface of still water; and White mentions instances where young swallows were fed with dragon-flies nearly as long as themselves. The young do not leave the nest until they are about ready to take full care of themselves. Finally, they are pushed off by the parents to make way for the second brood, and, inexperienced in the use of their wings, many fall a prey to crows and small hawks that lie in wait ready to pounce upon the first poor little fellow that launches upon the untried air. Those that manage to run the gantlet of the hawks, collect in small companies by themselves and have a good time hunting by day, and roosting at night among the river-reeds, until the autumn migration. "At this time Salerne observes," says Latham, "that the young are very fat, and in flavor scarcely inferior to the *ortolan*." Sometimes the parents forsake their progeny in the nest, and seem generally to care less for them than is usual among swallows.

But not the young alone are exposed to enemies. It would seem as though the situation of the nest precluded invasion, yet if they are near the haunts of the house-sparrow they are sure to be dispossessed of their homes by that buccaneer. Snakes, too, can sometimes reach their holes; weasels, like that one Mr. Hewitson tells us of, are often sharp enough to make their *entrée* from above: school-boys regard the pink-white eggs a fine prize; and, last and worst of all, the bank-swallows are many times utterly worried out of their galleries by fleas and young horse-flies, which swarm and increase in their nests until the bird finds endurance no longer a virtue, and digs a new *latebra*.

RECENT POLAR EXPLORATIONS.

TRANSLATED FROM THE FRENCH, BY EMMA M. CONVERSE.

THE regions called circumpolar, during the last six or seven years, have been the theatre of numerous explorations that have enriched our geographical maps with many new outlines. Doubtless, the recent discoveries have not succeeded in penetrating the mystery that envelops the arctic world, but, by strength of will, and thanks also to the connivance of chance—sometimes propitious to navigators—important points of departure have been obtained from extreme latitudes. It is well known that there are four distinct routes for approaching the basin of the Arctic Ocean: One, by Behring Strait, is formed by the

rent found between the northeastern point of extreme Asia and the very jagged promontories of the northwestern coast of North America. This was the route chosen by the Frenchman Gustave Lambert for that gigantic expedition, the preparations for which were followed with great interest by the learned world; but his unexpected death caused the abandonment of the enterprise. A second route, by Baffin's Bay, opens between the western shores of Greenland and the vast archipelago that commences at Hudson's Bay. This double entrance to the arctic seas has been for a long time the favorite course for English and American sailors. Europe, at the present time, seems to prefer two routes nearer its own territory, passing, the one, along the eastern coast of Greenland, the other between Spitzbergen and Nova Zembla.

These last-mentioned routes were formerly much frequented by the Dutch navigators like Barentz, but they have since been abandoned. Dr. Petermann, the director of the *Geographische Mittheilungen*, has succeeded in bringing once more into popular favor these desirable paths to the Polar Sea. Extensive and long-continued study gave to this geographer the conviction that the great warm current that issues from the Gulf of Mexico, between Florida and the island of Cuba, and takes a northern course, passing along the coast of Europe, must have a northern extension more considerable than had been heretofore supposed. In the month of July, 1865, Dr. Petermann for the first time developed this theory before the German Geographical Society in session at Hamburg. Supporting his argument by numberless experiments in soundings and measurements of temperature, he demonstrated the probable presence of the Gulf Stream in very high latitudes, and concluded that, after leaving Spitzbergen, the barrier of ice once overcome, a navigable ocean would be found. The routes that we have described would then be openings conducting to a kind of arctic Mediterranean, to which navigators could sail in a direct course, instead of wasting their lives in perilous and useless searches in the windings of the great circumpolar labyrinth. These bold deductions did not fail to meet with energetic opposition, especially in America and England; but five years later, in 1870, Dr. Petermann, returning to the charge with the data gained from a still more complete research, surmounted all controversy. He established the fact that the warm current advances as far as Spitzbergen and Nova Zembla, beyond the eightieth degree of latitude, and that, aside from some lateral branches, it sends its principal mass toward the northeast. At this latitude the temperature of the current descends to three degrees below zero, Centigrade. Experiments made by Dr. Bessels, of Heidelberg, in the course of one of the latest explorations, prove that the influence of the warm current is still perceptible beyond Bear Island. The real extent of the Gulf Stream is, however, a problem that has never been satisfactorily solved.

The scientific agitation fomented in Germany by the speeches and writings of Dr. Petermann did not delay to bear fruit, although the theory of the eminent geographer has not received the sanction of direct proof, which it still awaits. In 1868 a first expedition, under the command of Captain Koldewey, a sailor, educated at the school for pilots in Bremen, set sail from the port of Bergen. Although imperfectly fitted out, it had for a special mission to take the bearings of the northern prolongation of the east coast of Greenland. In case the explorer could not attain this coast, he must endeavor to refind on the east of Spitzbergen the famous land of Gillis, discovered in 1707 by the Norwegian Gilles, and since then forgotten and lost. The Germania (such was the name of the ship chartered for this purpose) directed her course toward the eastern coast of Greenland; but the agglomeration of ice preventing her approach, she turned toward the west coast of Spitzbergen, and then reascended toward the north a little beyond the eighty-first degree. Although the expedition was obliged to deviate from the path marked out, it was not without interest for the progress of hydrography and physical geography. It discovered that King William's Island, situated in the strait of Henlopen, was really an island, as Scoresby had indicated in 1822; and it corrected the boundary of Northeast Land, one of the largest islands of Spitzbergen. Besides, the year 1868 did not appear to be favorable for an attempt at landing on the east coast of Greenland, for the Swedish steamer Sophia, which made the same attempt under the command of Captain Baron de Otter, could not pass the icebergs, and was obliged to return in October, a month after the Germania.

The impulse once given was not allowed to diminish its force. Thanks to the zeal of Dr. Petermann, seconded by an indefatigable ship-owner of Bremerhaven, Mr. Rosenthal, the next year, 1869, numbered a dozen expeditions, almost all sent forth by the routes recently reopened. In February, the screw-steamer Bienenkorb left the Weser for the purpose of attempting a landing on the east coast of Greenland. The ice once more prevented the success of the enterprise. In May, another steamer, the Albert, commanded by Captain Haasgen and Dr. Bessels, set out to make the tour of Spitzbergen, to explore the sea between this land and Nova Zembla, and to discover, if possible, the land of Gillis. None of these three objects were accomplished, but the expedition determined more exactly the situation of the islands southeast of Spitzbergen, and confirmed the assertions of Dr. Petermann upon the distant extension of the Gulf Stream. The same year the English Captain Palliser, having for an object to sail around the shores of Nova Zembla, penetrated into the Sea of Kara, situated between that island and the Samoiede peninsula, and sailed along the Siberian coast, within a few leagues of White Island, without being at all impeded by the ice. Behind him, the Norwegian Johannesen traversed the same route twice without encountering any difficulty. By this

means the commonly-received belief was corrected, which represented as narrow and of little depth this basin, into which, by two neighboring estuaries, are poured the congealed masses of the Obi and Yenisei, as if it were the great ice-house of the north-pole.

The most important event of the year 1869, in the order of facts, was the second German expedition, which departed in June from Bremerhaven. This expedition, fitted out at great expense through the zeal of numerous committees, was composed of two ships, the screw-steamer Germania, seasoned already by a preceding exploration, and the sailing escort Hansa. Captain Koldewey, the commander-in-chief, was assisted by the Austrian Lieutenant Julius Payer, and several scientists. The instruction given to the voyagers, by the Central Committee of Bremen, marked out for them the eastern coast of Greenland as the principal base of operations, and the object to be accomplished was to study it scientifically, and to examine it in all its details. These labors completed, Mr. Koldewey and his companions would, if circumstances were favorable, direct their course as far as possible toward the pole; but, in any event, the extreme date of return was fixed upon the first of November of the following year. The two ships kept company, through good and evil fortune, as far as the seventy-fourth degree of latitude; there, a fatal error, a signal of the Germania incorrectly interpreted on board the sailing-vessel, separated the two ships forever. The Hansa, not having at command the resources of steam, was soon invested by the ice, about forty miles from the coast, and, after having, in this position, drifted considerably to the south, broke to pieces under the pressure of the ice-blocks that surrounded her. The crew sought safety upon an immense piece of floating ice, where they built of coal a winter hut that was destroyed in its turn. This new species of raft, which was at first seven miles in circumference, broke up or gradually melted during a perilous and capricious drift of six months, a part of the time in the darkness of a polar night, until at last the hour came when the unfortunate sailors measured only with anxiety the surface of their fragile domain. Happily, the current had carried them insensibly to more hospitable latitudes, and, as they had saved their boats, they seized the first occasion to set them afloat. Finally, by force of sail, towing, and transshipment, they reached Friedrichsthal, a missionary station situated at the southern point of Greenland, then Lichtenau, and Juliansshaab, where they found a steamer that landed them at Copenhagen on the first of September.

The Germania, more favored, had meantime the glory of accomplishing to the letter the very precise instructions of the committee of Bremen. The history of the voyage, filling four large volumes, deserves the closest attention, and will remain, until new discoveries are made, the indispensable manual of the navigator in the eastern part of Greenland. The difficulty of gaining access to these coasts, situ-

ated beyond the influence of the Gulf Stream, proceeds from the enormous quantity of ice carried by the polar current in this direction. The principal chance of success depends upon the direction of the prevailing winds. East and southeast winds render the icebergs more resistant and more compact; west and northwest winds, on the contrary, by driving back the blocks of ice in an opposite direction, cause a division and a crumbling that disentangle the labyrinths near the shore, and open numerous passes.

The Germania had this experience. During the month of July she struggled in vain against insuperable agglomerations of icebergs and ice-fields welded to each other. It was not till the commencement of August, when the predominance of breezes from the Atlantic had produced a loosening of the ice driven back between Iceland and Spitzbergen, that the ship opened a passage, and effected a landing in a small bay of Sabine Island, in the Pendulum Archipelago, below that part of the country called King William's Land.

It is well known that Greenland, visited several times from the tenth to the fifteenth century, then completely abandoned and lost, was rediscovered at the end of the sixteenth century by some Scandinavian sailors. The eastern shore, particularly, is only known since the voyages accomplished from 1822 to 1831, by Scoresby, Clavering, Sabine, and Graah; we do not speak of the unfortunate attempt made at the same epoch by the Frenchman, Jules de Blossville, who disappeared with his ship, and was never heard of afterward.

This eastern coast, relatively level from Cape Farewell, the extreme southern point, as far as Scoresby's Sound, suddenly changes its character as soon as the seventieth degree is passed. It offers at this latitude an infinity of bold promontories, deep and sinuous fiords, fantastically collected, with backgrounds bristling with gigantic glaciers, in comparison with which the most famous ones of Switzerland singularly lose their majesty. All this jagged, solid mass, has for an advance-guard a projection of islands generally very mountainous; the whole figure recalls a little the aspect of the coasts of ancient Asia Minor. The Germania penetrated into the centre of this labyrinth. As soon as she was anchored in her harbor, it was evident that she must remain a prisoner. The masses of iceberg, though temporarily affected by the summer heat, manifested no symptom of breaking up, and the channels, opened between the islands and the continent, began to close during the middle of August. According to the account of explorers, the formation of ice takes place in this manner. Small, isolated denticulations are accidentally formed near each other, without presenting at first any appearance of cohesion. Afterward a thick paste is produced, which is finally amalgamated into a crust, and this crust is so flexible that it reproduces without breaking the swelling of the surge. By the middle of September this ice could sustain the weight of the sleds. Mr. Koldewey and his companions improved the

opportunity, by the assistance of these vehicles, to visit several points of their archipelago; unfortunately, the autumn excursions in these lands continue only about five or six weeks. In the first days of November, the crew of the Germania saw the sun disappear for three long months beneath the horizon. Then commenced that terrible captivity in the midst of the polar night, and among frightful storms of snow.

The winter of 1869–'70 was made remarkable by a series of tempests from the north, one of which continued for more than a hundred consecutive hours with a velocity of about sixty miles an hour. The thermometer at the same time did not fall beyond 32° (Centigrade) below zero. Besides, even in the most severe temperature, if the chinks in the cabins are carefully stopped up, if the access to the ship is well defended by artificial casings of ice and snow, there will be little suffering from cold. The physical and moral discomfort arises principally from the impossibility, during more than ninety days, of observing the surrounding phenomena, and from the long-continued immobility in the midst of sinister darkness, illuminated alone by those strange celestial fairy scenes called aurora borealis. Outside, the congealed masses of every age and production, being pushed against each other with inimitable noises and grindings that sailors call "the voices of the ice," are welded in huge rafts, or form pyramidical entablatures sculptured with gigantic stalactites. The ship, however, well sheltered in a harbor open on the southern side, and protected on the north by a high rampart of mountains, can brave this frightful shock of the elements; but every thing depends, in case of emergency, on the fortunate choice of a station. The essential point is that the blockade, that assures the safety of navigators, should remain unbroken, and that no ricochet movement should reach the ship; the least rupture of the plain of surrounding ice, the least bar would be fatal; the most fearful peril is the neighborhood of running water.

The polar night, in the latitude where the Germania wintered, ended at the commencement of February; a month after, the sun remained long enough above the horizon to allow great sledge excursions. Then the truly scientific labor of the explorers commenced. This task represents a series of Herculean labors that baffles the imagination. The country not offering the least resource, the travelers were obliged to carry every thing with them; the heavy vehicle also played the *rôle* of that "ship of the desert," whose loss involves that of the whole caravan. Clothed with heavy furs, the face entirely masked, the tourists harnessed themselves to the sled; supported in some fashion in their hard effort in towage, they struggled against the cutting north wind. The eye, beset by the monotonous reflection of the white immensity, knew neither where to rest nor how to judge of distances; it was every moment the sport of mirages that vanished

to spring up again in another part of the horizon with the most deceptive effects of refraction. The activity and wakefulness of the nights increased the suffering of these marches where a geographical enigma was mingled, as it were, with every step, and where it was often the work of a whole day to accomplish a simple advance of a quarter of a league; but of what is not the constancy of man capable when science is the object of pursuit! The pioneers of the Germania advanced thus beyond the seventy-seventh degree of latitude by 18° 50′ west longitude from Greenwich. This year, at least, there was no trace of an open sea toward the pole, on the Greenland coast. Everywhere, on the north and east, the sea appeared to be solidly bridged by the ice. If provisions had not failed, the traveling colony would have been able to push on the sled indefinitely over these boundless plains. The iceberg, properly so called, without remarkable protuberances, extended for about two leagues from the shore, which, starting from this extreme point, seemed to take a northwest direction, where the perspective was obstructed by high mountains crowned with glaciers.

During the two following months, the voyagers explored, either in sleds or boats, the deep bays and fiords of the estuaries west and south of the Pendulum Islands. In the month of May, even in this high latitude, signs precursory of the fine season were manifest, and the first fruits of the meagre Greenland vegetation were seen in all directions. Under the bridges of snow and the coverings of the glaciers, the murmur of running water was heard; long flights of eider-ducks arrived from the south; the polar ortolan warbled its sweet note; the *lemmings*, a kind of northern rabbit, were seen among the fragments of the rocks; the white hares enjoyed the young sprouts of moss and saxifrage; while the reindeer, with its slender body, enlivened the depths of the torrents, and, at a distance, the curious head of the seal emerged through the sheets of ice, brightened and mellowed by the sun.

At last, on the 22d of July, 1870, the Germania floated once more in the open sea, and, after having remained 300 days in winter quarters, quitted the little harbor that had hospitably received her, in order to attempt, by the aid of steam, further progress toward the north; but, in latitude 75° 26′, a little less than the height she had attained the preceding summer, the channel suddenly failed. The summer influences had not disintegrated the enormous masses bound to the iceberg, and apparently this soldering would yield only to the autumnal tempests. But, these tempests coming at the end of August, the Germania, which, according to the instructions of the committee of Bremen, could make but one winter in these regions, resolved to return to Europe, and she was alongside the wharf in the Weser on the 11th of September.

The scientific results of the exploration were, on the whole, considerable. If the principal problem of polar navigation had not been solved, much more precise and extended notions concerning the physi-

cal and hydrographic nature of the most important northern country were attained. Mr. Koldewey, when he asserts that no continuous channel exists on the east of Greenland, draws perhaps too rigorous a conclusion from a simple experience of two years. But it appears doubtful whether, under any conditions, this coast can offer a favorable base for reaching the central basin of the north-pole, for, on one hand, the state of the channel near the shore is subordinated to all kinds of topical conditions difficult to foresee, and, on the other, the cold current, even at the season of the greatest loosening of the ice, causes immense quantities of huge blocks to drift in that direction. The country itself presents also to the scientist and geographer a very curious field for observation. The officers of the Germania found, from investigations skillfully conducted, that this part of Greenland is actually inhabited, and that it seems also habitable. They discovered the perfectly preserved remains of Esquimaux huts, veritable houses that the history describes very minutely, containing different instruments and utensils, whose primitive fashion recalls the work of the Stone age; but, for some reason, the polar man seems to have deserted, without a desire to return, these quarters, where the conditions of life, during the progress of ages, have been sensibly modified. The polar bear, improperly called the white bear, reigns as master among the glaciers of the coast, as the walrus, no less dreaded, reigns on the icebergs of the sea.

The most intelligent and the most active member of the important mission whose fortune we have followed, was undoubtedly Lieutenant Julius Payer. This officer, devoted heart and soul to the theories of Dr. Petermann, set out the next year (1871) with his countryman, Lieutenant Carl Weyprecht, to search for the land of Gillis. The two explorers did not succeed in finding it; but they penetrated 150 miles farther north than their predecessors had done in this region. Beyond the seventy-eighth degree, between 42° and 60° west longitude, there was still an open sea, and the temperature of the surface of the sea varied between three and four degrees (Centigrade) above zero. The want of provisions obliged the crew to turn back, and this was a great misfortune, for the year seemed exceptionably favorable. The Norwegian captain, Mack, who traversed at this time the eastern part of the same ocean, in search of the place where Barentz had wintered in 1579, met everywhere, at a distance that no one had before attained, navigable water with a strong current. The station of Barentz was, however, found a short time after on the northeast point of Nova Zembla by another Norwegian, Carlsen; it still preserved visible tokens of the abode of the Dutch navigator.

Another expedition, resembling the abortive voyage of the Hansa, in its dramatic catastrophe, if not in its results, was undertaken in this same year (1871) by the American captain, Hall, who adopted the route by Baffin's Bay, instead of the European entrance to the

Arctic Ocean. Captain Hall, in company with Dr. Bessels, starting from Newfoundland on the 29th of June, on the ship Polaris, shaped his course toward Smith's Strait, discovered by Kane seventeen years before, and at the end of August landed on Grinnell Land, in 80° north latitude. He ascended afterward to Kennedy's Channel, and penetrated into a narrow sound for about 100 leagues, where no mariner had ever ventured before. This passage was called Robeson, in honor of the Secretary of the Navy of the United States. Captain Hall advanced by this new route, that probably ended in the famous central arctic basin, as far as latitude 82° 16′, touching the extreme point on the 3d of September. There he perceived on the north a vast extent of open water that he called Lincoln Sea, and farther on another ocean, or a bay, on the west of which the outlines of a coast were delineated; this country was named Grant Land. Everywhere a fauna appeared similar to that of Greenland; herds of musk-oxen, white hares, and other polar animals, were seen, and they even thought that traces of human beings were perceptible. The crew was eager to make an opening through the iceberg; but the sailing-master of the expedition, Captain Buddington, would not permit the attempt, and the Polaris returned to winter in Robeson's Channel, in latitude a little above 81°. The death of Captain Hall, occurring in the month of November, put an end to every new endeavor to make any further advance on the northern coast; the winter was passed in inaction, and when the warm breath of the following summer had put the waters in motion, and delivered the Polaris from the fetters that bound her, the travelers hastened to descend to the south. The return was not entirely unimpeded. The ship underwent a terrible pressure; a part of the men, separated by chance from their companions, took refuge on an ice-floe, where they remained miserably stranded for 240 days. This ice-field, like the one that bore the waifs of the Hansa, was constantly drifting toward the south, and visibly shrinking, until, on the 30th of April, the shipwrecked sailors were seen by a passing steamer. As to the rest of the crew of the Polaris, obliged to abandon the leaky ship, they wintered on Littleton Island, whence they set out once more, on the following summer, in two boats procured from a Scotch whaler.

All these eventful voyages, so curious and exciting, are surpassed by the recent exploit of the steamer Tegethoff, whose almost fabulous experience was only known in Europe during the month of last September. Lieutenants Payer and Weyprecht, immediately after their return from the expedition of 1871, were detailed to prepare a new one. Nothing was neglected to give a character of unusual grandeur to this exclusively Austro-Hungarian enterprise. Two eminent friends of science, the Counts Wilczek and Zichy, lent to it their material and moral aid; the Royal Geographical Society, in February, 1872, advised the formation of a special committee, including among its members the most

illustrious names of the Austrian aristocracy, and a considerable sum of money was soon collected. The equipment of the mariners was the object of careful solicitude; they were so provided for that, without dreading cold and snow, they might go away hundreds of miles from the ship and be absent for months. The principal aim of the expedition was to study the unknown regions of the Polar Sea north of Siberia, and to see if it were possible to reach Behring Strait by this route; it was only as a secondary object, a kind of last resort, that the expedition could direct its course toward extreme latitudes; it was only permitted to venture in the direction of the pole if, in the course of two winters and three summers, it did not succeed in doubling the extreme promontory of Asia. The point of official departure of the scientific excursion was the northern coast of Nova Zembla.

The Tegethoff, having on board twenty-four persons, set sail from Tromsoë, Norway, on the 14th of July. Some days after a yacht sailed from the same port with Count Wilczek on board, whose purpose was to establish on an eastern point of the Arctic Ocean a depot of coal and provisions for the Tegethoff. On the 21st of August, off Cape Napan, between Nova Zembla and the mouth of the Petchora, the yacht lost sight of the steamer. More than two years passed before any news was received of the missing ship. Great was the anxiety in Austria and in the whole civilized world; heaven and earth were moved to aid the navigators who had so strangely disappeared. Count Wilczek had a quantity of small India-rubber balloons made, which, supplied with dispatches, were distributed to the whalers sailing for the northern seas, with directions to let them loose in the different stations of these territories. The Geographical Society of London gave an express mission to a ship bound for Spitzbergen, to inquire everywhere for the Tegethoff. The Russian Minister of the Navy, Mr. Siderof, instigated a public reunion for the purpose of sending a salvage expedition upon the traces of the unfortunate steamer.

Suddenly, on the 3d of last September, just at the epoch predicted by Dr. Petermann, who had constantly maintained that news of the explorers must not be expected before the autumn of 1874, a report was spread abroad from Vienna that the lost sailors had just landed in Europe. Some days after they made their entrance into the Austrian capital, welcomed by enthusiastic cheers whose echoes are still heard. The expedition, as often happens in these unconquerable polar seas, was not able to follow the terms of the official instructions. The Tegethoff, from the 21st of August, 1872, the same day when Count Wilczek saw her for the last time, found herself irretrievably invested by ice. In endeavoring to get free from this fatal imprisonment, the crew and the ship remained the passive sport of chance; on the 13th of October, the vessel received a thrust that lifted it up, and inflicted upon it heavy bruises. Let any one judge how agitated and terrible

this winter harbor was, at the mercy of the elements! The ice was in constant movement until the spring of the following year. At the end of March, 1873, the pressure came to an end, but the Tegethoff was incrusted in the midst of a plain of ice several leagues in circuit. For five months, from April to September, the crew worked in vain to restore the ship to its normal condition; the ice-plain in which it was incorporated was pushed by the winds in every direction, and at last ascended to 79° 54′ north latitude. The *rôle* of science then unexpectedly commenced; a consoling light for the mind and will of the explorers burst forth even from the bosom of blind fatality. On the 31st of August, 1873, after more than a year of terror and endurance, the ice-bound captives saw a mass of elevated coast, sparkling with glaciers, emerging from the fog, at a distance of about fourteen miles. They immediately gave to this apparition the name of Emperor Francis Joseph's Land. But it was not till the end of October that they were able to land on shores so miraculously discovered; even then, on account of the advanced season, they found it impossible to take possession; for they were soon to enter for the second time into the sinister polar night that continues three and four months. They took advantage of the last days that were illuminated with an expiring twilight to make little preliminary excursions some leagues from the ship, and this was all they could accomplish. They were then obliged to wait patiently for the next dawn of day, that is, until the spring of 1874.

This winter was more tempestuous than the preceding, and the persistent north winds brought interminable snow-storms; the thermometer fell to 48° (Centigrade) below zero. At last, on the 24th of February, the sun having reappeared above the horizon, they hastened to improve the spring weather. Lieutenant Payer prepared three expeditions with sledges drawn by dogs to reconnoitre the nature and configuration of the neighboring land. In the first excursion, from the 10th to the 16th of March, he visited the nearest island, where he found a most picturesque fiord with an enormous glacier in the background; there were summits 2,500 feet high. The second journey was much more important; discoveries succeeded each other as if by enchantment. Mr. Payer penetrated into a sound or strait—Austria Sound—extending from south to north, and completely covered with small islands. This strait was prolonged as far as the latitude of 82° between two continuous masses of land. The eastern side was called Wilczek Land, the other Zichy Land. In going out of this pass, the explorer encountered a vast basin, from which emerged another land, named Prince Rudolph's Land. The extreme point attained by Payer and his companions was called Cape Fligely; it is situated nearly at the same distance from the pole as that reached by another route, in 1871, by the captain of the Polaris. There it was necessary to stop, on account of the crevasses and ruptures produced at this season in the

ice of the fiords. A strait, terminated by another land, lay open before the eyes of the travelers, whose prolongation, inflected to the east, could be followed even beyond the latitude of 83°. They named it Petermann's Land. What is, then, this new world that remains provisionally the *ultima Thule* of navigators? It is not, certainly, according to the report of Mr. Payer, a mass of insignificant islands; it is an entire regional system with a development comparable to the archipelago of Spitzbergen. Could it be the Land of Gillis, so much sought for in these later times?

The explorers, on returning from this long excursion, having had the good fortune to find their ship immovable in the same place, set out very soon for a third tour in a western direction. When fourteen miles from the Tegethoff, they made the ascent of a high mountain, from the top of which they could trace the general configuration of the country; the most elevated summit was 5,000 feet high. Finally, the moment came for thinking of a return home. On the 20th of May, 1874, they put themselves *en route*, but they were obliged to abandon the ship. All the members of the expedition were safe and sound, the mechanician alone having died. During ninety days, by the aid of sledges and boats, sometimes on the ice, sometimes on the open sea, the glorious Austrian pioneers wandered in these unknown regions, following always the direction of the compass to the south. In the beginning, the winds thwarted their progress to such a degree that after two whole months they were only eight marine miles distant from the ship. Their provisions also were nearly exhausted, when, on the 18th of August, they reached Nova Zembla. Six days after they embarked on the Russian steamer Nicholas, which carried them to Warsoe.

If the vicissitudes endured by this memorable expedition, the official report of which has not yet reached us, give the measure of the difficulties experienced in following in these regions a preconcerted plan, they show also that with coolness and constancy the resistance of polar chaos may be overcome. A day will come, doubtless, when the conditions of arctic life will be in some measure familiar to us, and the navigator will face less timidly its sombre horrors. Already he has succeeded in discovering his way through good and bad fortune into the variable windings of the great labyrinth; he has sounded the depths, studied the currents and counter-currents; he knows at what season such a channel is obstructed or free, and what routes the ice-fields driven to the south follow in their regular migrations. The principal features of this exceptional geography are, then, partially established; the essential point is, that the succession of polar voyages shall be no more interrupted. Too long have arctic explorations been made in a desultory and capricious fashion; audacity and courage have been lavishly used, but consecutive action has been wanting. Experiments, in order to acquire their full scientific value, must be

continuous, and it is therefore necessary that all nations should in turn relieve each other, according to their resources, in this attentive sentinelship of the outposts of the arctic world.

SAVAGISM AND CIVILIZATION.[1]

By HUBERT H. B NCROFT.

THE obvious necessity of association as a primary condition of development leaves little to be said on that subject. To the manifestation of this soul of progress a body social is requisite, as, without an individual body, there can be no manifestation of an individual soul. This body social, like the body individual, is composed of numberless organs, each having its special functions to perform, each acting on the others, and all under the general government of the progressional idea. Civilization is not an individual attribute, and, though the atom, man, may be charged with stored energy, yet progress constitutes no part of individual nature; it is something that lies between men and not within them; it belongs to society and not to the individual; man, the molecule of society, isolate, is inert and forceless. The isolated man, as I have said, never can become cultivated, never can form a language, does not possess in its fullness the faculty of abstraction, nor can his mind enter the realm of higher thought. All those characteristics which distinguish mankind from animal-kind become almost inoperative. Without association, there is no speech, for speech is but the conductor of thought between two or more individuals; without words abstract thought cannot flow, for words, or some other form of expression, are the channels of thought, and with the absence of words the fountain of thought is, in a measure, sealed.

At the very threshold of progress social crystallization sets in; something there is in every man that draws him to other men. In the relationship of the sexes, this principle of human attraction reaches its height, where the husband and wife, as it were, coalesce, like the union of one drop of water with another, forming one globule. As unconsciously and as positively are men constrained to band together into societies as are particles forced to unite and form crystals. And herein is a law as palpable and as fixed as any law in Nature; a law which, if unfulfilled, would result in the extermination of the race. But the law of human attraction is not perfect, does not fulfill its purpose apart from the law of human repulsion, for, as we have seen, until war, and despotism, and superstition, and other dire evils come, there is no progress. Solitude is insupportable—even beasts will not live alone; and men are more dependent on each other than beasts. Solitude

[1] From vol. ii., "Native Races of the Pacific States.

carries with it a sense of inferiority and insufficiency; the faculties are stinted, lacking completeness, whereas volume is added to every individual faculty by union.

But association, simply, is not enough; nothing materially great can be accomplished without union and coöperation. It is only when aggregations of families intermingle with other aggregations, each contributing its quota of original knowledge to the other; when the individual gives up some portion of his individual will and property for the better protection of other rights and property; when he intrusts society with the vindication of his rights; when he depends upon the banded arm of the nation, and not alone upon his own arm for redress of grievances, that progress is truly made. And with union and coöperation comes the division of labor by which means each, in some special department, is enabled to excel. By fixing the mind wholly upon one thing, by constant repetition and practice, the father hands down his art to the son, who likewise improves it for his descendants. It is only by doing a new thing, or by doing an old thing better than it has ever been done before, that progress is made. Under the *régime* of universal mediocrity the nation does not advance; it is to the great men, great in things great or small, that progress is due; it is to the few who think, to the few who dare to face the infinite universe of things, and step, if need be, outside an old-time boundary, that the world owes most.

Originally implanted is the germ of intelligence, at the first but little more than brute instinct. This germ in unfolding undergoes a double process: it throws off its own intuitions, and receives in return those of another. By an interchange of ideas, the experiences of one are made known for the benefit of another, the inventions of one are added to the inventions of another; without intercommunication of ideas the intellect must lie dormant. Thus it is with individuals, and with societies it is the same. Acquisitions are eminently reciprocal. In society, wealth, art, literature, polity, and religion, act and react on each other; in science, a fusion of antagonistic hypotheses is sure to result in important developments. Before much progress can be made, there must be established a commerce between nations for the interchange of aggregated human experiences, so that the arts and industries acquired by each may become the property of all the rest, and thus knowledge become scattered by exchange, in place of each having to work out every problem for himself. Thus viewed, civilization is a partnership entered into for mutual improvement; a joint-stock operation, in which the product of every brain contributes to a general fund for the benefit of all. No one can add to his own store of knowledge without adding to the general store; every invention and discovery, however insignificant, is a contribution to civilization.

In savagism, union and coöperation are imperfectly displayed. The warriors of one tribe unite against the warriors of another; a

band will coöperate in pursuing a herd of buffalo; even one nation will sometimes unite with another nation against a third, but such combinations are temporary, and no sooner is the particular object accomplished than the confederation disbands, and every man is again his own master. The moment two or more persons unite for the accomplishment of some purpose which shall tend permanently to meliorate the condition of themselves and others, that moment progress begins. The wild beasts of the forest, acting in unison, were physically able to rise up and extirpate primitive man; but, could beasts in reality confederate and do this, such confederation of wild beasts could become civilized.

But why does primitive man desire to abandon his original state and set out upon an arduous, never-ending journey? Why does he wish to change his mild, paternal government, to relinquish his title to lands as broad as his arm can defend, with all therein contained, the common property of his people? Why does he wish to give up his wild freedom, his native independence, and place upon his limbs the fetters of a social and political despotism? He does not. The savage hates civilization as he hates his deadliest foe; its choicest benefits he hates more than the direst ills of his own unfettered life. He is driven to it—driven to it by extraneous influences, without his knowledge and against his will; he is driven to it by this Soul of Progress. It is here that this progressional phenomenon again appears outside of man and in direct opposition to the will of man; it is here that the principle of evil again comes in and stirs men up to the accomplishment of a higher destiny. By it Adam, the first of recorded savages, was driven from Eden, where otherwise he would have remained forever, and remained uncivilized. By it our ancestors were impelled to abandon their simple state, and organize more heterogeneous complex forms of social life. And it is a problem for each nation to work out for itself. Millions of money are vainly spent by benevolent people for proselyting purposes, when, if the first principles of civilization were understood, a far different course would be pursued.

Every civilization has its peculiarities, its idiosyncrasies. Two individuals attempting the same thing differ in the performance; so civilization evolving under incidental and extraneous causes takes an individuality in every instance. This is why civilizations will not coalesce; this is why the Spaniards could make the Aztecs accept their civilization only at the point of the sword. Development engendered by one set of phenomena will not suit the developments of other circumstances. The government, religion, and customs of one people will not fit another people any more than the coat of one person will suit the form of another. Thought runs in different channels; the happiness of one is not the happiness of another; development springs from inherent necessity, and one species cannot be engrafted on another.

Let us now examine the phenomena of government and religion in their application to the evolution of societies, and we shall better understand how the wheels of progress are first set in motion—and by religion I do not mean creed or credulity, but that natural *cultus* inherent in humanity, which is a very different thing. Government is early felt to be a need of society; the enforcement of laws which shall bring order out of social chaos; laws which shall restrain the vicious, protect the innocent, and punish the guilty; which shall act as a shield to inherent budding morality. But, before government, there must arise some influence which will band men together. An early evil to which civilization is indebted is war; the propensity of man —unhappily not yet entirely overcome—for killing his fellow-man.

The human race has not yet attained that state of homogeneous felicity which we sometimes imagine; upon the surface, we yet bear many of the relics of barbarism; under cover of manners, we hide still more. War is a barbarism which civilization only intensifies, as indeed civilization intensifies every barbarism which it does not eradicate or cover up. The right of every individual to act as his own avenger; trial by combat; justice dependent upon the passion or caprice of the judge or ruler, and not upon fixed law; hereditary feuds and migratory skirmishes; these and the like are that which moved our savage ancestors to like conduct, falls to, and, after a respectable civilized butchery of fifty or a hundred thousand men, ceases fighting, and returns, perhaps, to right and reason as a basis for the settlement of the difficulty. War, like other evils which have proved instrunents of good, should by this time have had its day, should have served its purpose. Standing armies, whose formation was one of the first and most important steps in association and partition of labor, are but the manifestation of a lingering necessity for the use of brute force in place of moral force in the settlement of national disputes. Surely, rational beings who retain the most irrational practices concerning the simplest principles of social life cannot boast of a very high order of what we are pleased to call civilization. Morality, commerce, literature, and industry, all that tends toward elevation of intellect, is directly opposed to the warlike spirit. As intellectual activity increases, the taste for war decreases, for an appeal to war in the settlement of difficulties is an appeal from the intellectual to the physical, from reason to brute force.

Despotism is an evil, but despotism is as essential to progress as any good. In some form despotism is an inseparable adjunct of war. An individual or an idea may be the despot; but, without cohesion, without a strong central power, real or imaginary, there can be no unity, and without unity no protracted warfare. In the first stages of government, despotism is as essential as in the last it is noxious. It holds society together when nothing else would hold it, and at a time when its very existence depends upon its being so held. And

not until a moral inherent strength arises sufficient to burst the fetters of despotism, is a people fit for a better or milder form of government; for not until this inherent power is manifest is there sufficient cohesive force in society to hold it together without being hooped by some such band as despotism. Besides thus cementing society, war generates many virtues, such as courage, discipline, obedience, chivalrous bearing, noble thought; and the virtues of war, as well as its vices, help to mould national character.

Slavery to the present day has its defenders, and from the first it has been a preventive of a worse evil—slaughter. Savages make slaves of their prisoners of war, and if they do not preserve them for slaves they kill them. The origin of the word, *servus*, from *servare*, to preserve, denotes humane thought rather than cruelty. Discipline is always necessary to development, and slavery is another form of savage discipline. Then, by systems of slavery, great works were accomplished, which, in the absence of arts and inventions, would not have been possible without slavery. And again, in early societies where leisure is so necessary to mental cultivation and so difficult to obtain, slavery, by promoting leisure, aids elevation and refinement. Slaves constitute a distinct class, devoted wholly to labor, thereby enabling another class to live without labor, or to labor with the intellect rather than with the hands.

Primordially, society was an aggregation of nomadic families, every head of a family having equal rights, and every individual such power and influence as he could acquire and maintain. In all the ordinary avocations of savage life this was sufficient; there was room for all, and the widest liberty was possessed by each. And in this happy state does mankind ever remain until forced out of it. In unity and coöperation alone can great things be accomplished; but men will not unite until forced to it. Now, in times of war—and with savages war is the rule and not the exception—some closer union is necessary to avoid extinction; for, other things being equal, the people who are most firmly united and most strongly ruled are sure to prevail in war. The idea of unity in order to be effectual must be embodied in a unit; some one must be made chief, and the others must obey, as in a band of wild beasts that follow the one most conspicuous for its prowess and cunning. But the military principle alone would never lay the foundation of a strong government, for with every cessation from hostilities there would be a corresponding relaxation of government.

Another necessity for government here arises, but which likewise is not the cause of government, for government springs from force and not from utility. These men do not want government, they do not want culture; how, then, is an arm to be found sufficiently strong to bridle their wild passions? In reason they are children, in passion, men; to restrain the strong passions of strong, non-reasoning men

requires a power; whence is this power to come? It is in the earlier stage of government that despotism assumes its most intense forms. The more passionate, and lawless, and cruel the people, the more completely do they submit to a passionate, lawless, and cruel prince; the more ungovernable their nature, the more slavish are they in their submission to government; the stronger the element to be governed, the stronger must be the government.

The primitive man, whoever or whatever that may be, lives in harmony with Nature; that is, he lives as other animals live, drawing his supplies immediately from the general storehouse of Nature. His food he plucks from a sheltering tree, or draws from a sparkling stream, or captures from a prolific forest. The remnants of his capture, unfit for food, supply his other wants; with the skin he clothes himself, and with the bones makes implements and points his weapons. In this there are no antagonisms, no opposing principles of good and evil; animals are killed not with a view of extermination, but through necessity, as animals kill animals in order to supply actual wants. But no sooner does the leaven of progress begin to work than war is declared between man and Nature. To make room for denser populations and increasing comforts, forests must be hewn down, their primeval inhabitants extirpated or domesticated, and the soil laid under more direct contribution. Union and coöperation spring up for purposes of protection and aggression, for the accomplishment of purposes beyond the capacity of the individual. Gradually manufactures and commerce increase; the products of one body of laborers are exchanged for the products of another, and thus the aggregate comforts produced are doubled to each. Absolute power is taken from the hands of the many and placed in the hands of one, who becomes the representative power of all. Men are no longer dependent upon the chase for a daily supply of food; even agriculture no longer is a necessity which each must follow for himself, for the intellectual products of one person or people may be exchanged for the agricultural products of another. With these changes of occupation new institutions spring up, new ideas originate, and new habits are formed. Human life ceases to be a purely material existence; another element finds exercise, the other part of man is permitted to grow. The energies of society now assume a different shape; hitherto the daily struggle was for daily necessities, now the accumulation of wealth constitutes the chief incentive to labor. Wealth becomes a power and absorbs all other powers. The possessor of unlimited wealth commands the products of every other man's labor.

But, in time, and to a certain extent, a class arises already possessed of wealth sufficient to satisfy even the demands of avarice, and something still better, some greater good is yet sought for. Money-getting gives way before intellectual cravings. The self-denials and labor necessary to the acquisition of wealth are abandoned for the en-

joyment of wealth already acquired and the acquisition of a yet higher good. Sensual pleasure yields, in a measure, to intellectual pleasure, the acquisition of money to the acquisition of learning.

Where brute intelligence is the order of the day, man requires no more governing than brutes, but when lands are divided, and the soil cultivated, when wealth begins to accumulate and commerce and industry to flourish, then protection and lawful punishment become necessary. Like the wild-horse, leave him free, and he will take care of himself; but catch him and curb him, and the wilder and stronger he is the stronger must be the curb until he is subdued and trained, and then he is guided by a light rein. The kind of government makes little difference, so that it be strong enough.

Granted that it is absolutely essential to the first step toward culture that society should be strongly governed, how is the first government to be accomplished; how is one member of a passionate, unbridled heterogeneous community to obtain dominion absolute over all the others? Here comes in another evil to the assistance of the former evils, all for future good—superstition. Never could physical force alone compress and hold the necessary power with which to burst the shell of savagism. The government is but a reflex of the governed. Not until one man is physically or intellectually stronger than ten thousand, will an independent people submit to a tyrannical government, or a humane people submit to a cruel government, or a people accustomed to free discussion to an intolerant priesthood.

At the outset, if man is to be governed at all, there must be no division of governmental force. The cause for fear arising from both the physical and the supernatural must be united in one individual. In the absence of the moral sentiment, the fear of legal and that of spiritual punishments are identical, for the spiritual is feared only as it works temporal or corporal evil. Freedom of thought at this stage is incompatible with progress, for thought without experience is dangerous, tending toward anarchy. Before men can govern themselves they must be subjected to the sternest discipline of government; and whether this government be just, or humane, or pleasant, is of small consequence, so that it be only strong enough. As with polity, so with morality and religion: conjointly with despotism there must be an arbitrary central church government, or moral anarchy is the inevitable consequence. At the outset it is not for man to rule, but to obey; it is not for savages, who are children in intellect, to think and reason, but to believe.

And thus we see how wonderfully man is provided with the essentials of growth. This tender germ of progress is preserved in hard shells and prickly coverings, which, when they have served their purpose, are thrown aside, as not only useless but detrimental to further development. We know not what will come hereafter, but up

to the present time a state of bondage appears to be the normal state of humanity—bondage, at first severe and irrational, then ever loosening, and expanding into a broader freedom. As mankind progresses, moral anarchy no more follows freedom of thought than does political anarchy follow freedom of action. In Germany, in England, and in America, wherever secular power has in any measure cut loose from ecclesiastical power and thrown religion back upon public sentiment for support, a moral as well as an intellectual advance has always followed. What the mild and persuasive teachings and lax discipline of the present epoch would have been to the Christians of the fourteenth century, the free and lax government of republican America would have been to republican Rome. Therefore, let us learn to look charitably upon the past, and not forget how much we owe to evils which we now so justly hate; while we rejoice at our release from the bigotry and fanaticism of mediæval times, let us not forget the debt which civilization owes to the tyrannies of Church and state.

Christianity, by its exalted unutilitarian morality and philanthropy, has greatly aided civilization. Indeed, so marked has been the effect in Europe, so great the contrast between Christianity and Islamism and the polytheistic creeds in general, that Churchmen claim civilization as the offspring of their religion. But religion and morality must not be confounded with civilization. All these and many other activities act and react on each other as proximate principles in the social organism, but they do not, any or all of them, constitute the life of the organism. Long before morality is religion, and long after morality, religion sends the pious debauchee to his knees. Religious culture is a great assistant to moral culture, as intellectual training promotes the industrial arts, but morality is no more religion than is industry intellect. When Christianity, as in Spain during the fourteenth century, joins itself to blind bigotry and stands up in deadly antagonism to liberty, then Christianity is a drag upon civilization: and therefore we may conclude that in so far as Christianity grafts on its code of pure morality the principle of intellectual freedom, in so far is civilization promoted by Christianity; but, when Christianity engenders superstition and persecution, civilization is retarded thereby.

Then Protestantism sets up a claim to the authorship of civilization, points to Spain and then to England, compares Italy and Switzerland, Catholic America and Puritan America, declares that the intellect can never attain superiority while under the dominion of the Church of Rome; in other words, that civilization is Protestantism. It is true that protestation against irrational dogmas, or any other action that tends toward the emancipation of the intellect, is a great step in advance; but religious belief has nothing whatever to do with intellectual culture. Religion, from its very nature, is beyond the limits of reason; it is emotional rather than intellectual, an instinct and not

an acquisition. Between reason and religion lies a domain of common ground upon which both may meet and join hands, but beyond the boundaries of which neither may pass. The moment the intellect attempts to penetrate the domain of the supernatural, all intellectuality vanishes, and emotion and imagination fill its place. There can be no real conflict between the two, for neither, by any possibility, can pass this neutral ground. Before the mind can receive Christianity, Mohammedanism, or any other creed, it must be ready to accept dogmas in the analysis of which human reason is powerless. Among the most brilliant intellects are found Protestants, Romanists, Unitarians, deists, and atheists; judging from the experiences of mankind in ages past, creeds and formulas, orthodoxy and heterodoxy, have no inherent power to advance or retard the intellect. Some claim, indeed, that strong doctrinal bias stifles thought, fosters superstition, and fetters the intellect; still, religious thought, in some form, is inseparable from the human mind, and it would be very difficult to prove that belief is more debasing than non-belief.

THUNDER-SHOWERS.

By J. W. PHELPS.

THE thunder-shower of Southeastern Vermont generally comes from the southwest. To understand why it should take this course instead of any other, we must examine the topographical character of the country.

The chain of Green Mountains extends throughout the State from south to north, inclining some degrees to the east of north. It presents a barrier to the prevailing general current of southwest wind, and in summer condenses the vapor which that wind bears, thus forming piles of cumulus cloud over the higher summits, or most wooded districts. The deeper ravines, or river-beds, on the eastern slopes of the mountains, run to the southeast, and open out on the wider valley of the Connecticut River.

In order to convey a more definite idea of our theory, we will choose a certain locality which may serve the purpose of a diagram to our demonstration; and this locality shall be the region of West River. This river takes its rise among the forests near the summit of the Green Mountains, at a height of some 2,000 feet above the level of the sea, and, flowing southeasterly forty or fifty miles, empties into the Connecticut River about ten miles from the southern boundary of the State.

During a hot summer day the sides of the deep valley of this river reek with intense heat, and cause a flow of moist air upward toward

the summits of the mountain-ridge, from the valley of the Connecticut, and also from the sea. This moist air, meeting with the general current from the southwest, piles up an immense mass of cumulus cloud, of many square miles in extent. So long as the intense heat prevails, this cloud increases in size; grows black and blacker with its dense vapor, and casts a gloomy, lurid glare over the face of Nature, darker than that of any eclipse. The vapor, pushed up by the ascending currents of heated air, attains to a great height above the sea, where the temperature is very low. But finally, at that hour of the afternoon when the heat begins to decline, the accumulated vapors, no longer augmented or sustained by heated air from the valleys below, fall in rain.

The effect of large cold drops of water, or perhaps of ice, making altogether millions of tons in weight, falling from a great height into a deep, narrow valley, is, not only to beat down the air into that valley, but to chill the air there; and the cold air, seeking the lowest level, tends to rush down the valley, at first near the surface of the earth, but growing deeper and deeper, until the cloud itself is borne away on the swift-rushing air-freshet of its own making.

The land beginning to cool with the declining sun and the cooling rain, causes the southerly breeze to slacken and die away, and the storm-cloud rushes on unobstructedly down the West River and the Connecticut, deluging and fertilizing the fields along its course, while its quick lightning and oft-repeated claps of thunder flash and resound among the reverberating hills.

The cloud passes on, and often the sinking sun comes out from behind it; the late hushed and frightened birds gush forth with new song; myriad drops hang glittering on the spray; the green is flushed with a brighter, fresher hue, and the glowing rainbow smiles serenely from the dark, retiring, and still grumbling storm.

This storm is followed the next day by delightfully clear weather, with a cool, exhilarating breeze from the northwest; though this is not always the case, the cloud sometimes overspreading the sky, losing its motion, and leaving the air damp and murky.

The thunder-shower, as we have thus described it, though limited to a small district of country, may be regarded as the type of all similar showers that occur in mountainous regions everywhere. Numerous modifications, however, of local origin will occur, due to various causes; and it would be a highly-interesting and valuable study to ascertain these causes for every particular case.

Yet as to whether the moving force of the thunder-gust is limited wholly to the causes here given, may well admit of a question. It is not improbable that a cloud, from its great height, may penetrate a high upper current from the northwest, and that both this upper and the lower current may contribute to its rapid motion of translation. It is well that these thunder-showers are movable, instead of being

stationary, as they often are at sea, for otherwise summer rains would not be evenly distributed over the face of the country; and the land in some places would be subject to exceeding moisture, while in other places it would suffer from the drought.

A few days after the above was written, a violent thunder-gust closed a warm afternoon. It was on the 1st of August, 1873. The day had been hot and peculiarly oppressive, as is usually the case before a violent storm. Between four and six o'clock P. M., a thunder-shower came down the valley of West River, and corresponded in its general features with the description given above; but it exhibited in addition other features which were entirely peculiar. The lightning struck in five notably different places in the village of Brattleboro, which partly borders the valley of West River near where it disembogues into the Connecticut River, and these places, instead of being elevated points, were, in all cases except one, among some of the lower ones. And they were nearly all in the same straight line, about a half or three-fourths of a mile in length, and at a short distance from the Connecticut.

The strokes that fell upon these points followed each other in pretty rapid succession, and were accompanied by thunder that had a sound as if partly suppressed. It was neither loud nor jarring, as thunder sometimes is. The rain fell in floods, and was very copious. Its abundance, rendering the air seemingly nearly half water, doubtless occasioned the subdued sound of the thunder, and perhaps greatly reduced the force of the shocks; for in no case was any considerable damage done. An upper corner of a two-story house was shattered, two other buildings were slightly injured, and several trees were marked by narrow channels down their trunks or branches. Together with the first house struck, one of two fir-trees standing near was grooved at the same time, and some of the splinters were found in the chamber nearest the shattered corner, although the window-blinds were closed and fastened. These splinters must have been driven up between the slats of the blinds, which would seem to show that the stroke was upward instead of downward. A window-curtain near the corner was torn to shreds. In the lower room nearest the corner there were no effects of the shock observed except upon a gilt cornice which was marked at intervals by black perpendicular bars, the gilding there having been burned or melted. The intervals between these bars were in some cases very narrow, and at others very wide. Two persons sitting in this room perceived no effect from the shock.

At one moment during the storm the wind came from the north or northeast. This wind was probably highly charged with electricity, which, being added to the electricity of the northwest current, produced such an excess of the fluid as to result in the rapid and numerous discharges which took place. The most of these discharges apparently occurred along the line where the two currents of air met. The

more easterly current of air may have come over the shoulder of the mountain on the opposite bank of the Connecticut River, or it may have come down the valley of that river, and met the current coming down the West River in the village of Brattleboro.

With respect to the direction in which the lightning struck whether up or down, it is not improbable that in every stroke of electricity there are two opposing currents, one up and the other down. The splinters which adhere to the first tree struck show this, some remaining attached by the upper end, and others by the lower.

Beginning in the north, the first in order of the objects struck were a house and a tapering fir-tree near by, within about ten or fifteen feet, and towering considerably above the house. The house had no conductor. A hundred paces from there, in a southeasterly direction, a locust-tree was struck. It stood in a grove of locust, maple, poplar, butternut, fir, and other trees, within about thirty paces from a conductor upon a neighboring house, and not far from a tall Lombardy poplar. A hundred paces farther on, and at a lower level, one of the higher branches of a lofty elm was struck. At the distance of another hundred yards, in the same general direction, stands the Congregational church, and near it the Baptist church, both about 130 feet in height, and with conductors apparently in good condition. These churches were unharmed. About 400 paces from there, and at a still lower level, stands the fourth point struck, which is a three-story grist-mill; and, finally, some 300 yards or more farther on, and more to the westward, on a comparatively high point of land stands the dwelling-house, the fifth and last point known to have been struck —the last, we mean, in following the direction, and not in the order of time. The effect of the strokes at the two extreme points was severer than any of the others.

Reports from other quarters of the country show that the electrical condition of the atmosphere of New England on the 1st of August was considerably disturbed, thunder-showers occurring at many different places. When this is the case, it is reasonable to suppose that two showers, following down two neighboring valleys, may come together, and thus double the amount of electricity that might be possessed by one alone.

The question here occurs, "Is there any common origin between these thunder-showers and the northern lights?" Are they not each but a different means of restoring a disturbed electrical equilibrium? If this is the case, we might infer that, when thunder-showers are numerous and violent, the displays of the northern lights will be less frequent and less active, and *vice versa;* though there may be cases in which both become more than ordinarily active.

One of the discharges of electricity which we happened to observe during the shower was perhaps that one which fell upon the grist-mill. Amid the floods of descending rain, it looked like falling sparks of

fire. It was about 600 or 700 yards from where we sat, and the sound of the thunder was more like that of the rocket than that which usually accompanies electrical discharges. In fact, the cloud probably passed *through* the village rather than *over* it; and the discharges were necessarily short, close, and without prolonged reverberations, such as may occur when the stroke is high, partly in dry air, and several miles in length, the sound from which must reach the ear at different intervals of time, thus producing a continuous rolling noise.

We are here reminded of another thunder-shower, of peculiar features, which occurred in Brattleboro in November, 1860. It was on the day of the first election of Mr. Lincoln to the presidency. A pine-tree was rent into fragments by it, and a passer-by, a voter, on seeing the extraordinary havoc that had been made, the white, shining splinters lying scattered over the ground, in all sizes, from the smallest sliver up to strips long enough for rails, exclaimed in great excitement: "The thing is all up now; for the old 'Rail-Splitter' is around at his work!" Even thunder-showers are wrested by some men into a political significance!

The circumstances of the case, however, would appear to have been these: A dense cloud, borne upon a low southwest surface-current of wind, was passing across the deep valley of the West River, half a mile or so from its mouth, when it was probably struck by a cool, dry mountain-breeze flowing down the valley. This breeze imparted new electricity to the cloud, which, being thus overcharged, gave out its surplus in a sudden shock, which took effect upon a group of pines. Every drop of water of which the cloud was composed we may regard as a small Leyden jar, as it were, the united force of which proved sufficient to rend in pieces one of the pines in an instant of time. The tree was some seventy feet in height, two feet in diameter, and stood, not on the heights immediately under the cloud, but low down, within a few paces of the river. It was broken square off twenty or thirty feet from the top; and this top fell straight down and stood leaning against the shattered stump, showing that the trunk had been rent asunder so suddenly as to occasion no obstruction to its fall! There were but two discharges of electricity from this cloud; and soon afterward the weather cleared up from the northwest.

THE AUSTRALIAN FEVER-TREE.[1]

DURING the present century, a great number of exotic plants and trees have been brought to Europe, or transplanted from their original habitat to other climes. In view of its usefulness, perhaps the blue-gum tree of Australia and Tasmania, belonging to the genus

[1] Translated from *Das Ausland.*

Eucalyptus, which includes upward of 150 species, holds the first place among these exotic plants. The *Eucalypti* belong to the natural order *Myrtaceæ*, and are indigenous almost exclusively to Australia and Tasmania. They are distinguished for a high development of the phenomenon known as heteromorphism—the same plant assuming a perfectly different habit at different stages of its growth. The species with which we are just now concerned, the *Eucalyptus globulus*, presents two very distinct forms: when the plant is young, the leathery leaves are opposite and sessile; this is a sort of larval state—the plant is not yet mature, and cannot produce flowers. But in the adult state the leaves are pedunculate and alternate, and then the plant flowers and bears fruit. This polymorphism, however, does not occur to the same extent in all species of the *Eucalyptus*, and it is almost altogether wanting in *E. cordata*.

The honor of having discovered the *Eucalyptus globulus* belongs to a French scientist, Labillardière, the botanist, who accompanied the Chevalier d'Entrecasteaux on his expedition in the year 1791, to search for the lost crew of La Pérouse. Labillardière's journal of May 12, 1792, at which date the expedition was in the Bay of Storms, Van Diemen's Land, indicates that even then this sagacious botanist anticipated the great value of this tree for ship-building purposes.

For a long time the *Eucalyptus globulus* was simply an object of curiosity, and many a botanic garden possessed it without any one knowing of the fact: thus M. Planchon assures us that he saw it in 1854 in the Paris Museum, under the name of *E. glauca*. In Tasmania the colonists well knew the value of their splendid blue-gum tree, and employed it for a thousand purposes. It became more generally diffused only after the colony of Victoria was founded, an event not yet forty years old. Two names are thenceforth specially connected with the history of the *Eucalyptus*, viz., those of Baron Ferdinand Müller, of Melbourne, the distinguished botanist, and of M. Ramel. From the Botanic Garden at Melbourne the *Eucalyptus* crossed the sea to Europe, Africa, and America, like many other plants from the same source which have been acclimated in foreign lands.

Justly, as we think, M. Planchon observes that the term acclimation is apt to suggest erroneous notions, and that it is based upon a profound misconception of the true nature of plants—their temperament, so to say. Plants are imported and become naturalized, if you please; but this adaptation in all cases takes place very slowly, gradually, by selection of individuals from successive generations, by the production of races or local varieties which experience shows to be the best fitted to adapt themselves to the special conditions of climate and environment in which they exist. Though there are many grades of naturalization, they can all be reduced to two categories, viz., that of plants which accompany man and domestic animals, and which never separate from them; and, secondly, those plants which, in order

to thrive in a foreign land, whether in the wild or the domesticated state, imperatively require care from the hand of man.

To the latter category belongs, as yet, the *Eucalyptus globulus*, at least in the extreme south of Europe and in Northern Africa. The tree has been introduced in those regions, cultivated there on a large scale, but not yet naturalized. But, further, we find it at the Cape of Good Hope, in the La Plata states, in California, Cuba, etc. It was brought to Algeria in 1854, but we date its introduction there more properly from the year 1861, when M. Ramel, whose name we have already mentioned, brought the seed thither from Melbourne. Soon a genuine *Eucalyptus furore* broke out: every one desired to own the beautiful tree, and they were planted in Algeria by the thousand. Like the agave and the opuntia, the *Eucalyptus* seems as though expressly intended for Algeria; it is not so much at home on the northern shores of the Mediterranean. In southern France, in Languedoc and Provence, after many years' experience, M. Planchon holds out no promise that the tree will ever increase so as to cover the land with forest, or dry up swamps. In Eastern Provence, the *Eucalyptus* has existed since 1858, and, between Cannes and Monaco, it thrives amid the gray-green olives and the Italian pines. Here the *Eucalyptus* is naturalized just as in Algeria. The well-known Princess Dora d'Istria is showing great zeal in promoting the naturalization of this useful tree on both shores of the Mediterranean. At Rome they are now making experiments with the *Eucalyptus globulus*. At the malaria-infested monastery, Tre Fontane, near Rome, one of the most insalubrious localities of the Campagna, the writer of these lines saw in April, 1874, young *Eucalyptus* plantations tended by French Trappists. On the other hand, the young trees planted in 1858, in the Botanic Garden of Pampelmousses, on the island of Mauritius, perished in 1868. The tree could not withstand the violent storms to which that island is exposed.

In their native soil several species of *Eucalyptus* attain an extraordinary height. Baron Ferdinand von Müller tells of a *Eucalyptus amygdalina* which, by its height (152 metres), might overshadow the Pyramid of Cheops, the loftiest structure erected by man. The *Eucalyptus globulus* does not, it is true, attain such extraordinary dimensions, but yet its trunk can yield boards of enormous breadth. The timber being distinguished for solidity, toughness, and durability, is in request for ships' keels. It possesses certain resinous properties which preserve it from decay, whether underground or in water. The growth of the tree is extremely rapid—a rare circumstance with trees having wood of firm texture. Especially in its early years does the tree grow with astonishing rapidity; but it goes on growing in height till about its eightieth year. After that time the stem, which is usually very erect, increases only in diameter. The stem rises to a great height before it sends out branches, and its summit is scantily crowned with

foliage. "Fever-tree" is the name given at Valencia, Spain, to the eucalyptus-trees planted there in 1860. The title is due to the fever-dispelling properties which the *Eucalyptus* possesses. In point of fact, those regions where this beautiful tree is indigenous, and where it grows into forests, enjoy a very healthy climate. But, further, we have evidence that the planting of the *Eucalyptus* in marshy localities counteracts paludal fever. This has been shown by experience at the Cape, in the provinces of Cadiz, Seville, Cordova, Valencia, and Barcelona; in Corsica, and in Algeria. At Pardock, distant a few miles from the city of Algiers, there was a farm on the banks of the Hamyse which was noted for its fevers, so that people died there "like flies," so deadly was the atmosphere. In the spring of the year 1867, 1,300 eucalyptus-trees were planted there, and even in July of the same year—the month in which the fever is wont to be most virulent—there was not a single case of disease, although the trees were then only nine feet in height; and the place has been free from fever ever since. In the vicinity of Constantine, the farm Ben Machydlin was in the like bad repute; all around it were swamps that never were dry, not even in the hottest summers. Still, in five years this great morass was completely dried by the planting of 14,000 eucalyptus-trees, and the health of the inhabitants has ever since been excellent. So Gue, near Constantine, once a place infested by fever, is now salubrious and free from fever, having been surrounded with a plantation of *Eucalypti*. The Abbé Felix Charmetan states that, at Maison Carrée, near Harrasch, the eucalyptus-plantations have rendered the use of quinine unnecessary. Finally, the same is said in regard to Cuba and Mexico. In the department of Var, Southern France, there is a railway-station situate in a very insalubrious locality. The place has become perfectly healthy since forty eucalyptus-trees were planted there.

These facts justify the hope that the *Eucalyptus* will yet free the Roman Campagna of its fever, and Garibaldi, who is now agitating the question of restoring to cultivation that wilderness, would perhaps do well to visit the Trappists of Tre Fontane, and acquaint them with his intentions.

The *Eucalyptus* has, in sundry instances, proved to be advantageous as a remedy for periodic fevers, and it furthermore possesses disinfecting as well as antiseptic properties. Distillation of the leaves and other parts of the tree produces an essential oil, the physiological effects of which upon both the sick and the well have been carefully studied by Dr. Gimbert.

The hardiness of the *Eucalyptus globulus* is still in dispute. It is asserted that the tree cannot endure the severity of our northern winters, and that it can hardly thrive save in a climate like that of its native habitat—Australia and Tasmania. In support of this view we

have the observations of many gardeners in the British Isles, who assert that the tree "cannot resist severe frost, and consequently does not last many years." "I have frequently seen," writes one, "young trees, ten, twenty, and even thirty feet high, in the Channel Islands, growing vigorously during a period of three, four, or more years in sheltered situations, but, on the appearance of severe frosts, killed to the ground." On the other hand, various correspondents of the *Gardener's Chronicle* write that, during the severe cold of last winter, the *Eucalyptus* was uninjured in the island of Anglesea, and in the west and south of Ireland.

THE SUN'S WORK.

THAT the Sun causes a saving of fire and candle was known to all antiquity from the day fire and candle were first invented; and that was nearly all they knew about him. Nothing more was known for ages. It was only yesterday that he set up the business of sketching portraits and no matter what. He did it so cheaply and so correctly as to rob poor miniature-painters of their bread; and then came another halt, though only a short one, in our knowledge of what the Sun can do. But now, the more we know about him, the more grounds do we find for surmising that he is a marvelous servant—perhaps master—of all work.

Among the *cartes de visite* with which the sun presents us, are now to be included his own, in various moods of temper and expression. Thanks to photography and spectral analysis, the solar phenomena are daily fixed on paper and submitted to the inspection of an inquiring public. They thus escape from the narrow and not very accessible domain of observatories, and enter the grand current of publicity. Both in America and in England, numerous specimens of astronomical photography are offered for sale. First as to merit stand the admirable photographs of the moon published by Mr. Lewis Rutherfurd; and those of the Sun's disk, which present the spots, the facules, and the brilliant marblings of his surface with as much clearness and as striking an effect as the very best telescope; and also those of the solar spectrum, whose stripes have been self-registered with a fidelity which leaves no room for cavil. The low price of the "Annuaire of the Bureau des Longitudes"—where M. Faye has published the essay from which this paper has derived its facts—does not allow it to give actual photographs; it is obliged to be content with carefully executed engravings from originals supplied by the Observatory of Wilna.

Cosmic meteorology, that is the meteorology of the universe con-

sidered as a whole, is a new and somewhat ambitious term which is striving to obtain a footing in science; and, as the Sun evidently plays one of the leading parts in it, we naturally ask what is his line of action and what he does. And our inquiries are advancing not only under the guidance of more extended views, but by the help of bold and patient research already resolutely carried out. Astronomers long concentrated (with great success) their talents within the limits of our solar system, ignoring the rest of the universe, as if it were necessarily excluded from the domain of positive knowledge. The first step taken out of those narrow bounds was Fourier's conception of the important influence of the temperature of interstellar space, due to the heat given out by the stars.

Fourier's notion has recently been amplified by the account which has been taken of the chemical radiations that reach us from the same source. On beholding tiny stars imprint their image on the photographer's sensitive plate in less time than the Moon herself, we cannot help believing that the actinic power of these myriads of distant strangers—outsiders to our system though they be—must exert some kind of influence upon our world.

Do not meteorites and shooting-stars put us in daily relation with cosmic materials, which reach us straight from the depths of space, or which have not formed part of our system for more than a few centuries? Moreover (and it is another view of the question), within our system itself we observe phenomena which we cannot attribute to the ordinary action of solar heat, and which, nevertheless, are evidently connected with the sun. From which we draw the obvious conclusion that the Sun has active powers of which we are ignorant; that the same is the case, perhaps, with the planets themselves; in short, that we have yet to investigate a multitude of relations between the earth and other heavenly bodies, of whatever kind. We naturally hope to prove the mutual influence of the stars, more particularly in respect to terrestrial magnetism and the electricity of our globe—as a striking instance of which may be cited M. Becquerel's happy hypothesis of the solar origin of atmospherical electricity. The only fear is, lest, once embarked in this line of speculation, we should be tempted to carry it too far.

There is less danger of error in studying certain actions of the sun which, though still mysterious, are constant and undeniable. By fixing our attention on the sun himself, the source of all energy here below, we run less risk of being led astray. For example: do we find, in known solar phenomena, any reason to believe that the Sun has other means of action besides his attraction, his heat, and his light? The answer, "Yes," is ready. The Sun possesses and exercises a plainly-marked repulsive power, of which meteorology has hitherto taken no account, although our atmosphere must experience its effects. Of the existence of this special force no doubt is entertained by astronomers

who have studied the astounding configuration of comets. Olbers believed in a repulsive action; Bessel in a polar force; Bond, recently, on the occasion of Donati's comet, so deeply studied in America, deduced from it a simply repulsive force, and M. Roche, of Montpellier, adopted the same idea.

At first sight, it seems very strange to find the same body producing at once two opposite actions, an attraction and a repulsion. Nevertheless, if these two forces act according to different laws, they may coexist without being confounded in one single result, and may produce perfectly distinct effects. It is thus that the Newtonian attraction, which subsists between the molecules of every individual body, is by no means confounded or incorporated with the electrical or magnetic phenomena of which that same body may be the seat, or with the repulsive actions due to heat.

Now, although the most delicate observation of the celestial movements (planets and satellites) has hitherto revealed attraction alone, it is impossible at the present day to deny that the striking phenomena displayed by comets betray the existence of a quite different force, capable of driving to a distance, with incredible velocity, the most loosely attached and most attenuated particles of the matter composing them.

When a comet, arriving from the depths of the firmament, approaches the Sun, describing round him an immense ellipse almost parabolic in form, it appears to us as a spherical nebulosity more or less condensed toward its centre—that is, in the shape assumed by a body whose particles have freely taken their places under the sole influence of their mutual attractions. The sun's attraction (which at that great distance is virtually equal for all those particles), does no more than draw the comet toward it, as a whole, and in a lump as it were, without affecting its shape. But, when the distance diminishes, the parts of this sphere nearest the sun are drawn with greater force than the more distant parts diametrically opposite, and the primitive spherical figure can no longer subsist. The comet tends to grow longer and longer in the direction of the ideal line which connects it with the sun, absolutely in the same way as our globe, in its liquid portion, is drawn out into two opposite swellings familiarly known as ocean-tides. Nay, more: if the bond of mutual attraction which holds the particles of the comet together is not sufficiently powerful, it will give way; under the sun's attractive action, the comet will be decomposed, scattering its materials along its orbit, gradually transforming itself into a sort of very elongated ring of dust, like those which Schiaperelli's discovery shows to be the cause of shooting-stars when the earth happens to traverse them.

This is all that can result from the sun's attraction. But matters do not end here; and comets which have resisted for ages the destructive agency of attraction, now present quite different phenomena,

which, consequently, can no longer be attributed to that force. We see them drawn out and lengthened in the direction of the above-mentioned ideal line; but the matter which gushed forth (so to speak) on the sunshiny side is quickly arrested and driven back, while on the opposite side the matter rushes out, without meeting an obstacle, with an impetuosity of which no earthly phenomenon can give an idea. In a few days there is thus produced a tail diametrically opposite to the sun; and this tail may stretch before our eyes to a length of ten, twenty, thirty, or even sixty millions of leagues.

So great, in truth, is the complexity of cosmical phenomena, even when connected with unknown forces, that we might despair of success were we not offered a resource of which astronomical science has often availed itself—namely, the comparison of phenomena which occur at the same periodical intervals. Long before the discovery of universal gravitation, it was easy to see that the tides depended on the moon, since the periodicity is identical for the oscillations of the sea and the movements of our satellite. In like manner, the most complicated phenomena of meteorology, if they manifest a periodical character and their course agrees with the period of other strange phenomena, betray thereby their connection, in some way or other, with the latter.

Let us take, as an illustration, the variations of the dip of the magnetic needle. Every day, that needle, suspended freely, deviates in the morning from the position of equilibrium, and every day returns to it in the evening, after an excursion of variable extent. These regular movements evidently depend on the presence of the Sun above the horizon of any given spot; they also depend on its geographical situation, for they increase with the latitude on one hemisphere, and change their direction in passing from one hemisphere to the other. They are not due to a magnetic action proper to the sun; for, even supposing it to exist, the Sun, in consequence of his enormous distance, would be incapable of exercising a directing influence on a magnetic needle; but they result from some unknown action exerted on the electricity of the globe, and on the currents resulting from it—currents which themselves react on the direction of the needle, and often seriously disturb its movements.

How are we to give a precise account of this mode of action? In the midst of so many unknown details, how are we to lay hold of those which really require our attention? Observation, only, aided by this special form of empiricism—pointed out by M. Faye in his "Notice," and here attempted to be described—can help us in the matter. The diurnal variations of the needle have been noted for nearly a century past; it is remarked that they are not constant from one year to another; that they present maxima and minima, epochs of greatest and least activity; that these maxima occur every eleventh year. The phenomenon is periodical, and its period is eleven years.

Does there exist in the Sun (for it would evidently be useless to seek elsewhere) a phenomenon with a similar period? If such is the case, we shall perhaps have laid our hand on a simple relation of cause and effect. At all events, it will be a valuable hint and a sort of first indication of the track we ought to follow. Now, the spots on the Sun observe a precisely analogous period. Every eleven years they offer a strongly-marked maximum of frequency, followed, after an interval of several years, by a minimum, during which the Sun appears every day without a single accident or blemish on his brilliant surface. We are led, therefore, to investigate the case more closely.

More closely, in fact, we ought to look; for the coincidence may not be strictly exact. In that case, the present agreement of the two phenomena would be purely accidental; at the close of several periods it would disappear, and we should have been the dupes of a mere illusion. But M. Faye quotes a comparative table of the periods of the solar spots and of terrestrial magnetism, drawn up by M. Wolf, of Zurich, from which it appears that even the slight anomalies that occur, in respect to the average period of one of these phenomena, are faithfully reproduced by the other. This remarkable coincidence was almost simultaneously pointed out by General Sabine, Monsieur R. Wolf, of Zurich, and Monsieur Gautier, of Geneva.

Thus the spots on the Sun—those amplified whirlwinds which, by digging hollows in his surface here and there, introduce into his brilliant shell masses (more or less considerable) of the cooler hydrogen which envelops it—exercise on magnetism a daily action which is perfectly sensible to us. The problem of these mysterious variations, thus circumscribed, becomes henceforth more accessible.

True, the problem is not solved by that solitary circumstance. The advent of the spots determines two influences: first, they sensibly reduce the extent of the active surface of the Sun, and consequently of his radiations; secondly, they cause in the chromosphere, and far above it, gigantic hydrogenous eruptions, whose effects we are unable to appreciate. But that is precisely the point on which we have to concentrate our means of investigation; it is exactly there that Science may hope to seize the word of the enigma.

And, since there is an enigma, we are all the more strongly urged to solve it, because the daily variations of the magnetic needle are not alone in being affected by the variations of the photosphere. The same mode of reasoning connects them with the appearance of auroræ boreales. Here we are on familiar ground, discussing a phenomenon visible to and admired by all. Already Arago had remarked a sort of connection between the apparitions of the northern lights and disturbances of the magnetic needle. The concomitance was singular. And now we find that those auroræ present, exactly like the variations of the magnetic dip, a period agreeing with that of the

sun-spots. A table drawn up by Mr. Loomis, without suspecting their remarkable coincidence, establishes it beyond a doubt.

Nor is this all. Once started on the road, empiric science follows the clew of its deductions. After the auroræ boreales come the cirri, the mare's-tail clouds, of a peculiar form, which float very high in the atmosphere, entirely formed of extremely minute spicules of ice. These have an intimate connection with auroræ boreales, and seem to be in some sort the atmospheric substratum or stage of all their manifestations. It is now endeavored to ascertain whether there does not also exist some relation between the frequency of those clouds and that of the solar spots. In short, there is now, in meteorology, an emulation of discoveries based on these analogies of periods or on the influence of the solar rotation. And we are bound to call attention to this novel tendency of astronomical research, which Donati, a few days before his death, characterized as the advent of a cosmic meteorology—that is, as already stated, of a meteorology in which account should be taken of the multiple reactions of the stars on each other, without limiting those reactions to the habitual forces of attraction and heat.

To this cosmic meteorology evidently belongs Fourier's notion of a combined action which the universe (leaving the Sun out of the question) exercises upon us by its calorific radiations. If the Sun were to go out, the temperature of the solar system would not sink indefinitely—or rather it would not fall to the absolute zero (273° Centigrade)—but would stop at a certain point, which Fourier estimated at 62° Centigrade below the freezing-point of water. The importance of this temperature must not be estimated by the abnormal figures which measure it: for it appears to be a condition of our very existence, by imposing a limit to the lowerings of temperature produced by the long nocturnal radiation of polar regions. It must be added that Messers. Huggins and Stone have recently justified this bold conception by measuring the heat radiation of several bright stars which they find superior to that of the Moon herself—who ought, one would at first sight believe, to reflect so fair a share of solar heat.

This, then, is the Sun's work. He controls the compass; he marshals the northern lights; he permits or forbids ice-crystal clouds to hover high in the atmosphere; besides performing other offices which we may not at present even suspect. And thus a deeper study of his nature and action tends to modify notably the face of Science, to enlarge our views, and to demonstrate more clearly by what multitudinous links terrestrial existences are connected with the entire universe.—*All the Year Round.*

THE ENDOWMENT OF SCIENTIFIC RESEARCH.

By RICHARD A. PROCTOR.

I.

THERE are questions admitting, when viewed in the abstract, of but one answer, which yet, considered in their practical aspect, present difficulties that are almost, if not wholly, insuperable. Among them must be reckoned one which before long will attract, as it pre-eminently deserves, the attention of the nation—the question whether it is desirable that the investigation of natural facts, regarded as a vocation, should be publicly endowed.

When I say that but one answer can be given to this question, viewed in the abstract, I draw two distinctions: 1. I consider only the question whether science deserves public recognition; and, 2. I suppose the question submitted only to those who can properly consider it—those, namely, who are at least acquainted with scientific methods, if not versed in scientific subjects. To many it may probably appear a matter of small importance whether science advance or stand still. The general public scarcely recognizes the position which Science has already taken, still less the position she is about to take. Men do not perceive that the gradual advance of science must modify the condition of the human race, not in material matters alone, but even more by its influence on the feelings and emotions. In the course of time—and of no very long time, if future progress accords with present promise—the motives now most potent among men will yield to worthier influences, arising from clearer insight into physical, physiological, and psychological laws. Science, using the word in its best sense, has now a limited extension; but it is as a leaven in the midst, by which the whole lump will be leavened. In the mean time, men attend, as of yore, to matters which they regard as far more important than the growth and spread of knowledge—matters which have made up the history of the nations during many centuries, but have tended little to the advancement of mankind. Political plotting and counter-plotting, within each nation and among different nations; the preparation and employment of armaments thus rendered necessary; legislation by which class distinctions are strengthened and class dislikes intensified; the working out of social arrangements barbaric in origin and absurd in most of their developments; controversies over religious questions more or less closely associated with primeval superstitions—these and such as these are the occupations to which the world mainly devotes the energies not absorbed in the general struggle for existence. Science, in the mean while, conscious of its strength and certain of its future, can afford to wait. "Its development," as

Tyndall has well said, "is as necessary and irresistible as the motion of the tides or the flowing of the Gulf Stream. It is a phase of the energy of Nature, and, as such, is sure in due time to compel the recognition of those who now decry its influence and discourage its advance."

That science is worthy of endowment will be admitted by every one competent to form an opinion. Yet I would remark, at the outset, that the reasons sometimes advanced by students of science in support of this proposition are not of the worthiest, though they may be those best calculated to secure the alliance of the unscientific. Even Tyndall has spoken of science as though its chief value resided in its quality as "a source of individual and national might;" and many have dwelt on its value as a means of adding to material wealth. It would be affectation to contemn such considerations, but assuredly they do not present the noblest qualities of science, the chief good which science is competent to work. It is as a potent means of culture that science is worthiest of recognition. The material gain derived from scientific research has no doubt been great; but it has been incalculably surpassed in value by the change which science has worked and is working in the minds of men. It is, indeed, precisely in this respect that unscientific persons most completely misapprehend the work which science is doing. They attach special value to those things which science is silently but certainly displacing. They are pained by the light which science is pouring on objects that had seemed venerable so long as their defects had been veiled under the gloom of ignorance. They are appalled when science would teach them to displace all false loyalties by the noblest loyalty of all—loyalty to the truth. But the student of science can deal with such errors as he would deal with errors of observation or with untrustworthy experiments. He is not concerned to war against them. To be angry with them would be as unscientific as to be angry with gravitation. The true teachings of science will be recognized in due time—with results easily foretold. It was predicted that the religion of mercy would bring, not peace, but a sword; the seemingly stern religion of truth will bring, not a sword, but peace into the world. To recognize the universal reign of law is to perceive the futility of lawlessness, no matter under what high or even sacred names disguised. The culture of man through the study of truth is the work of science in the future. And scientific research derives incalculably greater value from the fact that it affords material for scientific culture than because it may add to national or individual power, or become a means of increasing our store of material wealth. Even the benefits derived from those departments of science which tend most to ameliorate the condition of the masses, great though these benefits unquestionably are, must be esteemed small by comparison with those which will hereafter be derived from science as a means of mental and moral culture.

I am careful to deal with this point at the outset, because it removes any difficulty which might arise from the question of the relative value, commercial or otherwise, of various departments of science, or of different discoveries in any given department. Regarding science as a means of culture, all scientific discoveries are valuable, though not all equally so. Some which are least useful in the ordinary sense are preëminently valuable in this respect. To take an example from astronomy: Although it would be difficult to say that any scientific discovery cannot *possibly* confer material benefit on the human race, I suppose no discovery could promise less in this way than Sir W. Herschel's recognition of wide-spreading nebulosity in certain regions of the heavens. Follow out, however, the train of thought that this discovery suggests, and it will be found that the discovery has had an influence by no means insignificant in dispossessing ideas which have wrought in their day incalculable mischief. As Draper has well said, in his "Conflict between Religion and Science," the nebular hypothesis rests primarily on this discovery; and the recognition of the truth of that hypothesis compels us "to extend our views of the dominion of law, and to recognize its agency in the creation as well as in the conservation of the innumerable orbs that throng the universe." Is this recognition of the reign of law barren? Let the reader of the history of the last five hundred years consider only what would have been the influence, throughout that interval, of a clearly-defined and widely-spread belief in the dominion of law, and he will neither hesitate how to reply, nor question the value of such a belief in future ages. The doctrine of the universality of law, once understood by the masses, cannot but prove a safeguard against excesses such as have been and continue to be committed in the name of religion—a safeguard even against the very existence of the superstitions to which such excesses are due. The belief in universal law, regarded by many in these days as a rock ahead, will be one day recognized as a breakwater against seas which have been heavy and may be heavy yet again.

In this way of estimating the value of science, and therefore the importance of scientific research, we may find an answer to the difficulty which presents itself when we consider the actual position of scientific workers—the fact, namely, that the search for scientific truth affords the worker no direct means of maintenance. A man may give many years of labor to discover some great law of Nature, or some important scientific fact, and when he has achieved success he may find that his discovery is his sole reward. This, indeed, may be the sole reward he has wrought for. Indeed, I think the true student of science would wish to dissociate from his special subject of research all idea of material reward. Yet it is as true of the minister and interpreter of Nature as of the minister and interpreter of religion, that "the laborer is worthy of his hire."

If the scientific worker is wealthy, and therefore presumably has abundant leisure, he will seek no material reward (precisely as those scions of wealthy families who enter the service of religion seek, I suppose, no payment for their ministries). But it has been well remarked that "there is unfortunately no necessary connection between wisdom and the inheritance of riches; and consequently it is always within the bounds of possibility that a man of property may subsidize in his own person, not knowledge, but error, a mischievous crotchet, or a perfectly fruitless and impossible inquiry, and may employ the contents of a bottomless purse in compelling the attention of the world to it. . . . There is also no guarantee in the case of a private person . . . . that the investigator is sufficiently furnished with the preliminary knowledge or training to make his remarks fruitful. In short, work supported by private means is very likely to be *amateur* work, or *duplicate* work." [1]

Every man who desires to make researches in science, and who is not possessed of private means sufficient, not only for his support, but to provide for the expenses of his researches (in some cases necessarily heavy), must either select an occupation which will provide the required means without taking him from his special subject of research, or must simply withdraw from the scientific work he had proposed to undertake. The alternative may present itself to him at the outset of his career; or gradually as his scientific work becomes more and more difficult, through the pressure of other duties; or sudden losses may bring the alternative home to him, after original scientific work has already commenced. Of the third case I shall say little in what follows, as it is probably unusual, and, when it occurs, must, for the most part, lead to entire withdrawal from scientific work. In whatever way the alternative may present itself, the student of science who determines to continue his investigations is not troubled by any great difficulty in selecting the occupation which he will combine with the pursuit of knowledge. For the available occupations are few indeed.

There are some salaried posts to which light scientific duties (chiefly educational) are attached. But these are not commonly, I believe,[2] to be obtained at the beginning of a scientific life, nor readily by those who find the gradual pressure of expenses interfering with scientific labors. They are not, indeed, necessarily awarded to science-workers at all; nor, when so held, have they invariably been found to encourage steady work in science. I am speaking, be it understood, of offices, professorial or otherwise, where the special duties

[1] *Fortnightly Review* for October, 1874: Mr. Appleton on the "Endowment of Research."

[2] In speaking about salaried and official posts, I rely on information derived from others, my own avocations not having led me at any time, or being at all likely hereafter to lead me, to seek direct information on such matters.

are light, and where therefore it is to be understood that those appointed are expected to devote themselves to original scientific research. Where heavy duties are attached to offices of this kind, scientific research is necessarily checked. We have an example of this in some professorships in America, the holders of which are compelled to devote so much time to the routine of class-work, that they are barely able even to keep themselves abreast of the scientific work of the day. But in Great Britain there are several offices which would seem to have been specially designed to afford means and leisure for original scientific research. Yet, if we consider the total number of men holding such offices, their abilities, and their opportunities, we must admit that the results they achieve are not collectively so great as might be expected. In certain instances, indeed, it would almost seem as though election to these well-paid offices had been the sole end and aim of work seemingly undertaken from pure love of science, so thoroughly has original research ceased, or become unfruitful, when the desired post has been secured. We must not close our eyes to this fact, nor suffer the zeal and energy of the few to blind us to the negligence of many who hold such offices. The point is one which would have to be carefully considered in any scheme for the endowment of research. If physical research is ever to be freely endowed, some plan would have to be adopted to obtain honest and faithful workers—not men who would regard scientific discoveries only as a means of securing salaried idleness.

But most of the salaried offices at present open to science-workers have heavy, or at least wearisome, duties attached to them. A professor of science who has to attend daily in the class-room, to consider how to make clear to dull minds matters altogether familiar to him, to prepare or emend text-books, and to take also his share in the control of large bodies of young men, cannot possibly give any great portion of his energies to original research. "In a few cases," as Mr. Appleton remarks, in the paper from which I have already quoted, "a *little* research can be done; in the majority of probably the best instances, all that is possible to the teacher is to keep himself abreast of that which is being accomplished by others; in too many, it is to be feared that even this is rendered impracticable by the exigencies of continual publicity." This publicity, indeed, must be of all others the most annoying hindrance to scientific research. I say *must be*, because my own course of life (except for occasional short intervals, at my own choice and under my own control) has been so completely that of the recluse, that I can only imagine the effects of a continued slavery to "the exigencies of publicity." Yet I have seen enough to feel assured that what Mr. Appleton describes as "the available store of nervous power" must be drawn upon far too largely, in most instances, to leave much energy for original research.

There remains, so far as the association of science and education is

concerned, what may be called the literature of science. And here, I must confess, I do not share the opinion which has been expressed by some, that the purely scientific qualities must suffer in proportion as the expositional power is exercised. The habit of exposition developed by an educational calling may, indeed, as Mr. Appleton has remarked, "have a tendency to bring into prominence the element of form and phrase rather than that of substance," *if*, by an educational calling, we understand the routine of the class-room. Going continually over the same ground, the class-teacher must of necessity be unable to advance. But so far as the literature of science is concerned, even though the most elementary and popular forms of scientific literature be in question, this need not happen. The assertion that "the growth of the popular and rhetorical element—*die phrase in der Wissenschaft*—is almost always a symptom that the work of investigation is standing still," is not justified by facts. The most fruitful of our scientific workers are also those who have succeeded best in scientific literature. Sir J. Herschel, Lyell, Darwin, Huxley, Tyndall, Spencer, Grove, Lubbock, Tylor, Owen, Carpenter, Wallace: these are some among the men who have done most for the literature of science. They have not been checked in original research by the time devoted to such literature. Nay, I believe that every one of them would tell us that the hours so employed were among those most fruitful in suggestive thought, and therefore (by no means indirectly) in the advancement of original research. It appears to me—and here I speak to some degree from my own experience—that to write out a clear account of the results obtained during scientific work is so useful an exercise, that, apart from all question of the utility of popular treatises on science, the scientific worker should adopt the practice for his own sake. I feel sure that certain crude theories, which have been maintained by some who pride themselves most on avoiding the popular and rhetorical element, would have been abandoned had they been submitted to this process.[1] For my own part, however, I attach so much importance to the extension of sound scientific knowledge—so much more importance to this, I will even say, than to the results of the scientific researches of any man, or even of any body of men—that I regard as most earnestly to be deprecated all attempts to deprive our people of the literary services of those alone who can write effec-

[1] Prof. Tyndall was, on one occasion, berated and underrated for one of his most useful treatises, by an opponent of rhetoric, a skillful mathematician, who had advanced a theory about comets which would have crumbled into nothing under the test of popularization. To popularize a theory one must present it clearly, and therefore one must conceive it clearly. (Boileau said well, "Ce que l'on conçoit bien s'énonce clairement.") But, to conceive a theory clearly, one must view it in so many aspects that, if it has any flaws, they are almost certain to be recognized. I believe every successful popularizer of science must have had this experience—that a theory which had seemed satisfactory under ordinary scientific tests has been found wanting when he has endeavored not only to describe the theory itself clearly, but also the arguments for and against it.

tively or satisfactorily about science—the scientific workers themselves. Too long what has been called the popularization of science has been attempted by unscientific persons. When men like Herschel and Lyell, Darwin, Tyndall, and Huxley, undertake the real popularization of science, we have at once the promise and the sign of progress. "But," Mr. Appleton says, "there is not wanting evidence that the popularization of science, in the best and most necessary meaning of the word, is in this country beginning largely to take the place of original study and investigation of truth." Where, however, is this evidence? Mr. Appleton must have been sorely pressed, when he can only find it in the fact that "in Oxford, where the business of education has been brought to a pitch of perfection almost unequaled elsewhere, the actual additions to knowledge that are made, in the course of a generation, in the old traditional studies of Latin and Greek philosophy, are, as compared with what is done in Germany, almost inappreciable." I am not concerned to deny this, or even to question it. It is the natural result of old traditional arrangements. But it proves nothing concerning the effect of the popularization of science in the best sense of the word—and as distinguished from what is often so called, but might more correctly be termed the vulgarization of science. It seems to me undeniable that the great improvement which has of late taken place in the work of correct scientific exposition has synchronized with a great increase in the amount of fruitful original research. I say simply that the two developments have synchronized; but I am strongly of opinion that they stand to each other in the relation of cause and effect. Not only does it appear to me that our Herschels, Darwins, Huxleys, Tyndalls, and so on, have gained as science workers rather than lost, by their work in popularizing science, but I cannot doubt that the number of science-workers, in the several departments to which their writings relate, has been largely increased by treatises which combine sound science with clear and elegant exposition.

There is another aspect in which the improved scientific literature of our time must be considered. It is unfortunate that modern scientific progress necessarily tends to increase the number of specialists. Not only is it impossible for any man to thoroughly master several departments of scientific research, but no man can be thoroughly master of a single science in all its developments. It is absolutely necessary that there should be specialists—nay, every real worker in science must be a specialist. But while each science-worker has thus, and should have, his special branch of his own science, it is very desirable that he should also have a correct general view of other sciences. If he ought to know every thing about something, there is no reason why he should not know something about every thing.[1] It

[1] "The specialists," says Wendell Holmes, "are the coral insects that build up a reef. By-and-by, it will be an island, and, for aught we know, may grow into a continent. But

is just this something which the student of one science learns from a sound exposition of another science by a proficient therein. Every true popularizer of science knows that among his readers, if not even forming the greater number of his readers, there will be men of science, working in other branches, but still bringing to the study of his treatise their scientific training. Writing for them, he will write in the manner best suited to popularize without vulgarizing science: "the coarser developments of sensationalism" will be avoided, even if the good sense of the scientific worker were not normally opposed to all such faults of style. The literature of science owes much to the recognition of this circumstance.

Some may question, however, whether scientific literature can be sufficiently remunerative to support science-workers, even though they should turn altogether from original research, and devote their whole time to writing about science. I do not think, however, that much anxiety need be felt on this score. Of course, scientific literature is not at present, and perhaps may never be, so remunerative as novel-writing, historical literature, biography, travels, and so on. Very few writers on science, however general the interest attached to their researches, have earned an income of (let us say) five thousand pounds annually for many successive years; and I suppose the successful novelist would regard such an income as contemptible. Probably, in the majority of instances, it would be only by an almost entire withdrawal from original work that the writer on science could earn a steady income of half that amount; while that earnestness in the cause of science which can alone render scientific writings attractive would compel the scientific author to devote a large share of his time to unremunerative work. Yet there can be no doubt that many of our most successful workers in science have been able, without forsaking original research, to gain very sufficient incomes by scientific literature, or by the associated work of popular scientific lecturing. The chief objection, perhaps, to this way of rendering scientific research self-supporting consists in the fact that every hour devoted to

I don't want to be a coral insect myself. I had rather be a voyager that visits all the reefs and islands the creatures build, and sails over the seas where they have as yet built up nothing. I am a little afraid that science is breeding us down too fast into coral insects. A man like Newton, or Leibnitz, or Haller, used to paint a picture of outward or inward Nature with a free hand, and stand back and look at it as a whole, and feel like an archangel; but nowadays you have a society, and they come together and make a great mosaic, each man bringing his little bit and sticking it in its place, but so taken up with his pretty fragment that he never thinks of looking at the picture the little bits make when they are put together." This is true of specialists who are only specialists. But there can be no reason why the student of science should limit his attention to his specialty, though there is abundant reason why he should avoid any attempt to make *researches* over too wide a range of ground. His researches in his own special corner of science will lose nothing in value, but gain greatly, by an occasional survey of the work of others; only let him not pretend to take part in actual work in many parts of the field he thus surveys.

original work involves a pecuniary sacrifice, and the temptation must, in some instances, be strong to withdraw entirely, or for long intervals, from the real work of scientific research—even if this may not become, in many cases, an absolute duty.

Another source of remuneration for scientific workers depends on the value of scientific knowledge in certain departments of commercial enterprise. This means of support, however, though large in individual instances, is so limited in scientific range, that we need not stop to consider it in connection with the general question of support from workers in science. As Mr. Appleton justly remarks, "this source of maintenance is not only the exclusive privilege of physical science, but almost the exclusive privilege of one of the physical sciences. There is no commercial career open for a biologist, for instance; and the existence of a commercial career—and frequently a very lucrative one—for the chemist has the effect of starving all the other sciences for the benefit of one of them. One of our foremost teachers of biology complained to me not long ago that he was compelled to advise his best pupils, who were desirous of devoting themselves to a life of research, to give up their own study, and enter upon that of chemistry, as there was no prospect of a career for them in any thing else."

I have not spoken thus far of salaried offices which are apparently scientific but in reality involve continuous labor not tending greatly to the advancement of pure science. Such, for example, in astronomy, are the various offices, ruling as well as subordinate, in our great government observatories. The details of observatory-work are not, properly speaking, scientific. They involve, no doubt, the continuous application of scientific principles, but no such processes as are likely to lead to discoveries in science. The ordinary notion, for instance, that the large telescopes of our national observatories are employed in advancing our knowledge of astronomy, is altogether erroneous, as any one will perceive who examines the records of the work done in those observatories. All the original researches effected at Greenwich, since Flamsteed's time, would together form little more than a fair life's work for a single zealous student of astronomy, and would be incomparably surpassed in scientific interest by the work of either of the Herschels. The object for which government observatories are erected, in fact, precludes almost entirely the pursuit of original researches. The observations of the moon, for instance, which have formed so important a part of the work accomplished at Greenwich since Flamsteed's time, were not intended to add to our information about the physics of astronomy, though, of course, they have done so in a remarkable degree, studied as they have been by mathematicians (mostly outside Greenwich) from Newton downward. Their ostensible object was the improvement of navigation; and almost every observation made at Greenwich, until quite recently, was directed either to

this end (the improvement of navigation as a science) or to secure continued time-measurements, magnetic data, and other information for the guidance of seamen.—*Contemporary Review.*

SKETCH OF WILLIAM ROBERT GROVE.

THE subject of this sketch is a typical example of that remarkable class of men who achieve great eminence, both in business and in science; he is a very distinguished scientific investigator, having not only made his name a household word in all chemical laboratories where galvanic batteries are used, but he was one of the early pioneers in establishing the grand doctrine of the correlation of forces, and is known and esteemed throughout the scientific world for his share in this great movement. He has also been a hard-working professional lawyer, forcing his way to legal distinction among his countrymen, becoming queen's counsel, until at length, passing from the bar to the bench, and taking a distinguished rank among the judges of England.

WILLIAM ROBERT GROVE was born in Swansea, Wales, July 14, 1811, and received his early education at the Swansea Grammar-School. His father, who was a magistrate, intended him for the Church, and he was sent to Oxford in 1830, completing his university term with honor in 1833. He had conscientious scruples that were opposed to his father's desires, and he adopted the profession of the law. He also married about this time, and quitted England for a while to travel on the Continent for his health. In this leisure he took to the reading and study of electricity, soon followed by original experiments and important discoveries in this branch of science. In 1835 he became Professor of Natural Philosophy in the London Institution, a place which he held for five years. His scientific researches have been mostly in the field of electricity, and his contributions on this subject have been numerous in the "Philosophical Transactions," the *Philosophical Magazine*, and other journals of science. In 1839 we find him communicating to the Académie des Sciences de Paris the fact that if a positive electrode be immersed, half in water, and the other half in a tube of hydrogen, and a negative electrode in water and oxygen, the water ascends in the tubes, the galvanometer is deflected, and the water is decomposed and recomposed by voltaic action. This same year he communicated to the French Academy his invention of the galvanic battery, now bearing his name, in which platinum is substituted for copper, and nitric acid for sulphuric. He also published in this connection a paper on the "Inaction of Amalgamated Zinc in Acidulated Water," in which this phenomenon was first satisfactorily explained. About the same time he discovered that if

two pieces of gold are placed one in a cell of nitric and the other in one of hydrochloric acid, separated by an earthen-ware partition, no chemical action takes place; but, if the two pieces be connected by a wire, the acids immediately attack them. In 1840 he was elected a Fellow of the Royal Society, and in 1841 he published a paper "On the Combinations, by the Voltaic Battery, of Azote and Hydrogen with Metals." This same year he excited a great deal of interest by exhibiting, before the Electrical Society, daguerreotype pictures engraved by electricity. The picture was joined with the positive pole of a battery, and placed in hydrochloric acid; the chlorine set free attacked the silver surface unprotected by mercury, and from this etched surface an electrotype was made to be printed from. Though now in active practice at the bar, he continued his electrical investigations. He brought out his voltaic gas-battery, and wrote a paper on its applications to endiometry; published a "Memoir on the Action of Phosphorus, Sulphur, and the Hydrocarbons in the Gas-Pile;" and a communication on the "Electric Action by the Approximation of Dissimilar Metals without Contact," in which he showed that when a disk of zinc and one of copper are approximated without touching, and then separated, the gold leaves of an electroscope diverge, proving the existence of a radiating force capable of exciting electrical disturbance. In January, 1842, Mr. Grove delivered a lecture at the London Institution "On the Progress of Physical Science," in which the doctrine of the correlation of physical forces was briefly but clearly enunciated. He delivered a course of lectures at the same place, in which he explained and illustrated the propositions briefly laid down the year before. The position he sought to establish was that heat, light, electricity, magnetism, chemical affinity, and motion, are all correlatives; that is, that either of them, as a force, may produce the others. As an illustration, in one of these lectures he used a train of revolving wheels; the smallest, or that which revolved most rapidly, was of metal, and contained a piece of phosphorus in it. While this revolved with great rapidity, the phosphorus remained cool, but by a contrivance the wheel was suddenly stopped, and the phosphorus took fire; the object of the experiment being to show that *arrested motion* becomes heat. In 1847 he issued his work "On the Correlation of Physical Forces;" and in 1852 he published a memoir in the "Philosophical Transactions," on the "Electro-Chemical Polarity of the Gases." In 1856 he experimented upon the application of electricity as a mechanical power, and showed that, when by electrical attraction or repulsion, a weight is suspended, it is at the expense of electric tension, and that the spark cannot traverse the same distance that it could traverse, with the same apparatus and charge, without the elevation of the weight. Other researches of his have been on "The Electricity of Flame" and the formation of a flame-pile capable of producing chemical decomposition.

CORRESPONDENCE.

To the Editor of the Popular Science Monthly:

DEAR SIR: Last summer, at the Hartford meeting of the American Association for the Advancement of Science, a new constitution was adopted, and, under its provisions, a permanent subsection of "chemistry, chemical physics, chemical technology, mineralogy, and metallurgy," was organized.

Prof. S. W. Johnson, of Yale College, was elected chairman of the new subsection for the ensuing year, and the undersigned was deputed to make the necessary efforts to insure a full attendance of chemists and others interested in the application of chemistry. The meeting for the summer will be held at Detroit, commencing the 11th of August, and continuing about a week. It is very desirable that there should be a full attendance in the new subsection, in order to make it a success. Will you be so kind as to call the attention of your readers to the subject, either by printing this card, or by an editorial notice?

Any one who is interested in chemistry, mineralogy, or in any application of these sciences, will be welcome. Hitherto, chemistry has been but little represented in the proceedings of the Association, and the time now seems to have arrived in which some good work can be done.

Respectfully,

F. W. CLARKE.

EDITOR'S TABLE.

UNDER FALSE COLORS.

THE so-called "Association for the Promotion of Social Science" held its last meeting in May, in Detroit. It is reported as a satisfactory session, there having been a good attendance, much interest, and a full invoice of papers upon the varied topics which it is the habit of the body to consider. That the Association performs a useful function in securing the discussion of grave public questions, and in disseminating information, more or less useful, concerning them, we are not at all disposed to question; but we miss (as we did a year ago) any thing in the proceedings answering to the definite object of the organization as put forth in its title. The name of the Association is entirely misleading: it avows one object, and pursues others; it professes to do a certain work of very great public importance, and then, by totally neglecting it and doing something else under its name, it produces a mischievous confusion in the public mind, and becomes detrimental to the very purpose which it distinctly professes to advance.

As judged by its title, the Association was instituted to do an explicit thing, that is, to promote a certain science. Now what does this imply? It implies doing for the particular branch of science chosen, just what other associations do for the promotion of other branches of science. It implies, first, a branch of knowledge capable of assuming a scientific shape, and of definition and limitation in its objects; secondly, it implies efforts and measures for the elucidation of the subject, the extension of observations upon it, the generalization of its facts, by the same patient processes and cautious method that are adopted in other sciences with the single and supreme object of arriving at the truth; and, lastly, it implies men who will devote themselves to the cultivation of the subject in the true scientific spirit, men trained to original

inquiry, widely informed in the subject-matter of investigation, and determined to push it forward in new directions, and arrive at trustworthy and valid results. Social science is to be promoted, if promoted at all, in this manner, and by such men. It implies the systematic treatment of social phenomena, with the view of reaching a definite, coherent, and settled body of social truths, by the collection, analysis, and classification of the proper data of the subject. If the science is in its infancy, and has as yet been only roughly outlined, the work of its cultivators must needs be elementary, and the proceedings of any body of its true promoters will necessarily be characteristic of the stage or state of the subject. In the growth of all the sciences there has been an inevitable order of mental procedure, an advance from simplicity to complexity, from the uniform to the multiform, from the lower to the higher; but though this method has been necessarily followed, mental power has been immensely wasted by ambitious essays to resolve the larger and more difficult aspects of phenomena first. Yet the sciences have been actually and only built up by laying the foundations first and erecting the superstructures afterward.

But all this is of small account to the members of the "Association for the Promotion of Social Science." They do not seem, in fact, to know what the science is that they have assumed the task of promoting. They were in a muddle about it at starting ten years ago, and, if we may judge from the secretary's report, they are much in the same condition still. At any rate, they have little notion of plodding among the rudiments of the subject.

There were able disquisitions at Detroit on Finance, International Law, Life-insurance, Ideal Education, Medical Charities, Immigration, State Churches, Steamship-lines, etc., etc., but they had none of them any more to do with the science of the social relations of mankind than the proceedings of any other convention of thoughtful men called to deliberate upon important public affairs.

We make these remarks in no captious spirit, and we cordially concede the usefulness and importance of much of the work done by this organization: we are only speaking in the interest of that which the Association professes to do, but really does not even recognize; and what it pledges itself to do or to attempt, by the very title it takes, we hold to be far more important than all it accomplishes. The working out of the principles of social science, of the natural laws of the social state, into a clear, comprehensive, and authoritative form, is a matter of great moment, both because the state of knowledge at the present time makes it more possible and practicable than ever before, and because the results of even its partial accomplishment will be of immense value in the management of social affairs. And because of its grave importance, we strenuously object to any perversion or misappropriation of the term to illegitimate uses. We object to its employment as merely a dignified title for miscellaneous speculations on human affairs. Social science is a something yet to be achieved—a well-defined branch of inquiry yet to be elaborated by the prolonged efforts of painstaking thinkers; and we protest against its use as a kind of imposing category for the schemes of philanthropists and the projects of reformers. It may seem a matter of small importance what name an association chooses to adopt, but it is not so in the present case. The misuse of terms leads to false views that are liable to produce the most injurious consequences. No one can be better aware of the potent misleading influence of words upon the public mind than the distinguished president of the Detroit meeting, Hon. D. A. Wells. He perfectly understands that only a few people go beyond the word to the qual-

ity of the thing indicated. He knows that the policy of restriction imposed by the State upon the freedom of commercial interchange, by which monopolists are enriched, the people plundered, the Government corrupted, and the country disgraced, is intrenched in popular misconception, because it has got itself labeled "protection." The case before us is equally in point. So long as the term "social science" is employed to characterize the heterogeneous and discordant opinions of unscientific men upon the most intricate and refractory problems of civilized life, it will be discredited in its true application.

The American Social Science Association has been running for ten years, and its British prototype has had a conspicuous career for twice that time, but so little have they done toward the real promotion of the subject, so little to prepare the public for it, and so much to disseminate erroneous views respecting it, that the most comprehensive and solid contribution yet made to sociological science—a work entirely free from speculation, and which aims to lay the foundation of the science by collating and arranging the elemental facts descriptive of all types of social structure—cannot get patronage enough even to pay for carrying on the publication; and the real difficulty is the false impressions of the subject that have been fostered and disseminated by those who have acquired weight with the public as its promoters.

CORRECTED AGAIN.

THE ex-President of Harvard College, writing in the *Unitarian Review*, revives the perversion of Prof. Tyndall's views on the prayer question in the following pointed words: "Let the President of the British Association refrain from insulting Protestant Christians by proposing an arithmetical test of the reality of the communion of the soul with God." We are curious to know where Dr. Hill got his evidence for the charge that Prof. Tyndall has ever proposed "an arithmetical test of the reality of the communion of the soul with God," or any evidence that he has ever questioned that reality. To the conception of prayer as inspiration, communion with the Divine Spirit, or the expression of devotional feeling, we are not aware that Prof. Tyndall has ever made the slightest objection. On the contrary, we know, by his own repeated avowals, that he recognizes the religious efficacy of prayer as a "strengthener of the heart," which "in its purer forms hints at disciplines which few of us can neglect without moral loss." Again, he observes: "It is not my habit to think otherwise than solemnly of the feeling that prompts prayer." This, surely, is very far from being the language either of denial or of insult.

As to the so-called prayer-test, it was not to try "the reality of the communion of the soul with God" that Sir Henry Thompson proposed it, and Prof. Tyndall indorsed it by sending the anonymous article to the *Contemporary Review*. The object was, indeed, very different from this. It was to determine the validity of what may be called the physical theory of prayer; to ascertain the value of petitions to God for intervention in producing designated physical effects, such as changing the weather, augmenting the crops, or staying disease in special answer to such petitions. It was to the conception of prayer as critical and advisory, as objecting to this and calling for that, as invoking a potency that is available to man for the attainment of specific ends in the natural world, such as can be only in this way secured, that it was proposed to apply some rational method of verification.

The effects claimed being physical, it is the legitimate work of science to search out and measure every agency by which they are influenced. Nor

is even this the sinful occupation that religious people often assume, for the laws of Nature are the laws of God, and no man can be more reverently occupied than in investigating their operations. The laws of God, we venture to think, do not shrink from any thoroughness of verification, and those who conceive themselves insulted by the application of the balance or the spectroscope, geometry or arithmetic, to any of the physical operations of the world, must entertain a very narrow and morbid view of the divine government. It would seem that the old religious prejudice against the study of Nature, as a profane occupation of the human mind, in contrast with the sacredness of theological studies, still survives, and that the old conflict is yet very far from having died out. If it be said that the doctrine of answer to prayer, by immediate and miraculous suspension of the course of natural changes, has passed away, and has been replaced by the doctrine that the answer comes through the operation of natural laws, we reply, that the proof of this position is wanting. We hazard little in the assertion that, if the question were submitted to the suffrage of Christendom, those who hold to this interpretation of prayer would not only be in a paltry minority, but would be voted as infidels and apostates from the faith. The fact cannot be escaped that multitudes of devout people still strenuously hold to immediate divine intervention in the course of natural things, in response to human supplication. A periodical before us, representing the faith of half the Christian world, says: "Suppose, then, that a whole city full of people should testify to the resurrection of a dead man from the grave; would we be justified in rejecting the testimony on the sole ground of the physical impossibility of the occurrence? . . . History abounds in instances of the sort, in recitals of sudden cures witnessed by thousands, of conflagrations suddenly checked, of plagues disappearing in a moment." That such beliefs were universal in past times is notorious; that they have been dissipated from many minds is purely owing to what is called the encroachment of science. But the mass of people are still very far from having so clear, and settled, and strong a conviction of the physical order of Nature, that they will not lend a willing ear to the most preposterous stories of its violation. What is the lesson of the gross ghostology of modern spiritualism, before which even educated people will throw up gravity, and all the laws of physics, at the first puzzle of a juggling exhibitor, unless it be that the scientific doctrine of the government of the world by inviolable law is yet far from being firmly rooted in the general mind. Those who entertain such loose views of the constitution of Nature will almost necessarily take to the superstitious side of religion, and resent all attempts to submit their beliefs, even where they involve physical effects, to the test of science.

LITERARY NOTICES.

THE LIFE AND GROWTH OF LANGUAGE: An Outline of Linguistic Science. By WILLIAM DWIGHT WHITNEY. Pp. 326. New York: Appletons (International Scientific Series, Volume XVI.). Price, $1.50.

EVER since the fifteenth century the study of languages, particularly of Latin, Greek, and Hebrew, has formed the basis of a "liberal education;" and yet it was not till our own day that such a thing as a science of language was thought possible. Generation after generation trod the beaten path of grammar, loading the memory with formulas of accidence and syntax, learning by heart whole books of the "Iliad" and the "Æneid;" a few, and only a few, getting an insight into the habits of thought of the great poets, philosophers, orators, and historians of antiquity. For the few the study of the classics was an inestimable benefit: it undoubtedly did serve to broaden and lib

eralize their minds; but the many derived from their toilsome labors absolutely no fruit. On the contrary, this mill-horse toiling up and down, and round and round, ever treading the same old tracks of declension and conjugation, ever "parsing" and translating without being able to see whither it all tended, could serve only to dull and deaden all the faculties of the mind, and to stamp out all originality.

The old school in language had a theory of the origin of the various tongues of mankind: they all sprang from one—the Hebrew. Whether true or false, this theory was unproductive of results which could, by any possibility, inform or instruct the mind, for it was at the same time affirmed that the descendants of the Hebrew language were purposely so distorted that human ingenuity would ever fail to show a connection between the children and the parent, or between the children themselves. But, by the researches of modern scholars, even the arbitrary (for so they, till recently, seemed to be) modifications of words, as found in declension, conjugation, and the like, have been traced to their sources, and good reasons ascertained why they are thus and not otherwise. In this way caprice is eliminated from language, and law set up in its place; language is made amenable to scientific treatment.

Prof. Whitney's book outlines with wonderful clearness the science of language; and in the deservedly popular series to which it belongs there is not one volume which surpasses this as a simple and lucid exposition of a scientific theme. His method is to start from obvious, familiar truths, to exemplify by facts that are well known, and hence he is always, in his speculations, within easy reach of the reader. This common-sense mode of treating his subject is seen in Prof. Whitney's discussion of the question, How is language obtained by us? "There are few," he says, "who would not at once reply that *we learn* our language; it is taught us by those among whom our lot is cast in childhood." And this reply the author accepts as the true one, rejecting two other answers: that language is a race-characteristic, and as such inherited from one's parents, like the physical constitution; and that it is independently produced by each individual, in the natural course of his bodily and mental growth. The author then proceeds to show that language is *not* inherited, and that it is *not* evolved by the mind of the individual, but simply learned, acquired by hearing and practice.

As an illustration of the influence upon language of conservative and alterative forces, Prof. Whitney very happily selects a verse (Matthew xii. 1) from the Anglo-Saxon Gospels and compares it with the same verse in our modern English: "Se Hælend fôr on reste-dæg ofer æceras; sôthlice his leorningcnihtas hyngrede, and hi ongunnon pluccian thâ ear and etan." Modern version: "Jesus went on the Sabbath-day through the corn; and his disciples were an hungred and began to pluck the ears of corn and to eat." In the Anglo-Saxon version it is not easy for the ordinary English reader to recognize the words as familiar, and yet, by translating it as literally as we can, we find that almost every element in it is still good English. Thus: The Healing (one) fared on rest-day over (the) acres; soothly, his learning-knights (it) hungered, and they began (to) pluck the ears and eat. By means of this one passage Prof. Whitney indicates all the change-influences to which language is subject. These are: "I. Alterations of the old material of language; change in the words which are still retained as the substance of expression; and this of two kinds or sub-classes: 1. Change in altered form; 2. Change in content or signification. II. Losses of the old material of language, disappearance of what has been in use; and this also of two kinds: 1. Loss of complete words; 2. Loss of grammatical forms and distinctions. III. Production of new material; additions to the old stock of a language, in the way of new words or new forms; external expansion of the resources of expression." Five chapters of the work are devoted to an exposition of the influence of these various causes upon language.

We have not space for more than mere mention of the titles of the remaining chapters of the work, viz., Dialects; Indo-European Language; Linguistic Structure; Material and Form in Language; Other Families of Language: their Locality, Age, and Structure; Language and Ethnology; Nature and Origin of Language.

THE SEXES THROUGHOUT NATURE. By ANTOINETTE BROWN BLACKWELL, Author of "Studies in General Science." Pp. 240. G. P. Putnam's Sons. Price $1.25.

THE line of argument upon the woman-question which was opened by Mrs. Blackwell in an article in THE POPULAR SCIENCE MONTHLY on the alleged antagonism between growth and reproduction, and which was subsequently still further pursued in these pages by Dr. Frances Emily White in papers on "Woman's Place in Nature," is carried out in the present volume with considerable elaboration. It is a monograph, written to establish, on scientific grounds, the equality of the sexes throughout Nature. Both Mrs. Blackwell and Miss White are students of science, and recognize that in its later progress, especially in biology and psychology, it has direct and important bearings upon the issues raised in the women's movement. They recognize Darwin and Spencer as representing the most advanced scientific results, but object to the conclusions at which these gentlemen have arrived, on the subject of the relations of the sexes. Mrs. Blackwell's work is therefore not an attempt merely to expound the present state of science, but it aims to controvert conclusions deemed erroneous, and which have weight because emanating from high authorities. Of her book we may say that it is written in a clear and excellent style, contains much interesting information which will be fresh to many readers, and abounds in acute suggestions and ingenious views, while the publishers have got it up in an attractive form.

But, considered as an original scientific argument, we fail to see that Mrs. Blackwell has advanced or altered the position of the question she has taken up. She undertakes to prove that throughout all Nature the sexes are equal. We will not say that this is an impossible task; but if it be attempted in a truly scientific spirit we have no hesitation in saying that even the proximate solution of her problem belongs to the very distant future. For what she proposes to do is nothing less than to reduce the whole organic world, with all its vital and psychical characters, into exact and demonstrable quantitative expression. She puts the problem sharply, saying: "This is a subject for direct scientific investigation. It is a question of pure quantity; of comparing unlike but strictly measurable terms. In time it can be experimentally decided and settled by rigid mathematical tests." Accordingly, she reduces the elements of her subject to the form of equations, and, making an analysis of the characters and functions of the sexes in insects, fishes, cetacea, birds, herbivora, carnivora, and man, she aims to establish the equivalence of their relations. Special attributes she admits to be variable, but, taking the totality of attributes and bringing them together as balancing quantities, she maintains that throughout Nature the sexes are strict mathematical equivalents of each other.

Mrs. Blackwell seems to us to be quite oblivious of the difficulties of the task here undertaken. We know how long and painfully even the lower and simpler sciences toiled through their qualitative stages, before they reached the possibility of entering upon their quantitative relations. And we know, too, how the difficulties have thickened in prosecuting these sciences to their higher stages, even where all the effects are capable of being dealt with by direct experiment. But when we pass to the organic sciences these difficulties are immensely heightened. That organic phenomena are governed by quantitative laws is no doubt true, and it is the duty of science to work them out as fast and as far as it can; but, considering the vastness of the work, we can hardly regard it as yet fairly begun. Certain important physiological constants have been determined with some accuracy of general expression. The weight of the parts—skeleton, muscles, and brain—the proportions of chemical constituents, the rates of respiratory change, the statistics of circulation, the balance of assimilation and waste, and the relation of the expenditure of mechanical force to the food consumed, have been arrived at in a general and proximate way, after centuries of labor by the physiologists of all nations. Even to these results it would be wholly inadmissible to apply the term exact. But, when we rise to more complex organic manifestations, to the functions of the nervous system, to feeling and thought, and those pro-

portions and combinations of characters which distinguish classes and individuals, nothing whatever has been done toward their quantitative elucidation, and we can only say that the phenomena are vaguely comparable as more or less.

To illustrate the difficulties of attaining exact ideas in relation to quantity, we may refer to the history of chemistry, a science in which all the phenomena are at absolute experimental command. A century ago the law of exact proportions in chemical combination was arrived at, and, from the equality of affinity and neutralization among different bodies, they were held to be equivalents of each other, and the term "equivalence" came to be settled and fundamental in expressing chemical relations. But, after a hundred years of the closest thinking and the most exact experiment, we now find that the "old chemistry" is swept away, and the idea of "equivalence," which was its corner-stone, has gone with it. With the new facts, and finer discriminations, and broader views that have arisen, a whole crop of new terms has sprung up, and, instead of the equivalence of combining bodies, we now speak of their "univalence" and "multivalence," their "bivalence," "trivalence," "pentivalence," etc.; and, finally, the whole set of relations has to be expressed by the general term "quantivalence." But if the conception of equivalence is thus discredited in one of its oldest and simplest scientific applications, what meaning can it have when applied to phenomena that have not yet even taken on the quantitative form? We can write down the contrasted characters of the sexes, as Mrs. Blackwell has done, and carry them out to no end of detail, and prefix the terms *plus* and *minus* to the elements that are brought into comparison, and thus give a general idea of Nature's compensations; but to undertake to add up or to reduce to any strict equational form these most indefinite things seems like trifling. With man the scheme of comparison is carried out to nineteen particulars, of which the following five are examples:

MALES.	FEMALES.
— Structure.	+ Structure.
+ Size.	— Size.
+ Strength.	— Strength.
— Endurance.	+ Endurance.
— Products.	+ Products.

We looked over this enumeration with special interest, to see what value would be assigned to maternity, the grand function of the female sex, to which every thing else is subordinated. But it is either left out of the estimate, or must be included under products. Maternity is thus so generalized as to be described in terms applicable to both sexes. Now, we do not like this depreciation of the feminine side. Denying, as we do, the equality of the sexes, and holding to the superiority of the female sex, we protest against the degradation of woman implied in losing the supreme and distinctive purpose of her nature among the *plus* and *minus* products common to the sexes.

THE TEXT-BOOK OF BOTANY, MORPHOLOGICAL AND PHYSIOLOGICAL. By JULIUS SACHS, Professor of Botany in the University of Würzburg. Translated and annotated by ALFRED W. BENNETT, F. L. S., assisted by W. T. THISELTON DYER, F. L. S. Macmillan & Co. Pp. 848. 461 Illustrations. Price $12.50.

THIS admirable translation of the work of Prof. Sachs supplies a want long felt in our literature. Students who have been cut off from the German work, by their inability to read that language, may congratulate themselves that, for once at least, the translation offers advantages not found in the original. The Germans, it is well known, are doing a very large proportion of the world's thinking, and it has been hinted that the German consciousness of this fact is perhaps somewhat exaggerated, and may sometimes betray its men of learning into an unprofitable ignoring of the labors of other nations. But no criticism of this kind will hold against the present volume. Its translators, being themselves eminent botanists, have enriched the work with comments and contributions embodying English thought and discovery in this important division of science. We may also add that the German work reached its fourth edition while the translation was passing through the press, so that the new views adopted by the author, and the new matter added, are indicated in the English volume.

This text-book of Prof. Sachs is at once comprehensive in scope, and minute and accurate in detail. It is the aim of the author

to introduce the student to the present state of knowledge in botanical science. He not only explains the phenomena of plant-life already accurately known, but also indicates those theories and problems in which botanical research is at present engaged. References are given throughout the volume, which direct the student to those writings that contain fuller discussions of the points in question, that he may be enabled to form for himself an enlightened judgment. The illustrations are mostly original, and many of them the result of laborious investigation.

The work consists of three divisions: General Morphology, Special Morphology, and Physiology. Under General Morphology, there are three chapters treating: 1. Of the morphology of the cell; 2. Morphology of the tissues; and 3. Morphology of the external conformation of plants. Special morphology deals with the groups of plants as at present arranged in classes. Physiology is treated in seven chapters: 1. On the molecular forces in the plant; 2. Chemical processes in the plant; 3. General conditions of plant-life; 4. Mechanical laws of growth; 5. Periodic movements of the mature parts of plants, and movements dependent on irritation; 6. The phenomenon of sexual reproduction; 7. The origin of species.

The general reader, who is interested in modern scientific discussion, will find this an entertaining volume, because of its vital relation to questions uppermost in modern thought. For instance, the world-wide interest in "protoplasm" aroused by Prof. Huxley's address at Edinburgh, finds ample satisfaction in the explanations of cell-structure and cell-function. As bearing upon this subject we quote the following, which will be new to many readers:

"Under this head" (*Myxomycetes*) "is included a numerous group of organisms which, in many respects, differ widely from all other vegetable structures, but, in the mode of formation of their spores, stand nearest to fungi, on which account we may treat them as a supplement to that class. The *Myxomycetes* are remarkable in no ordinary degree from the fact that, during the period of their vegetation and assimilation of food, they do not form cells or tissues. The protoplasm, which in all other plants is also the general motive power of the phenomena of life, remains in them during the whole of this period perfectly free, collects into considerable masses, and assumes various shapes from the internal force residing in it without becoming divided into small portions, which surround themselves with cell-walls (or become cells). It is only when the protoplasm passes into a state of rest in consequence of being surrounded by unfavorable conditions, or when it concludes its period of vegetation by the formation of the reproductive organs—its internal and external movements ceasing at the same time—that it breaks up into small portions which surround themselves with cell-walls, and which even then never form a tissue in the proper sense of the term."

The book is penetrated throughout with modern views in biology, and also illustrates the truth of the remark that, while other nations are disputing about the doctrines of Darwin, the Germans accept them, and are working on the new basis afforded by them. In the chapter on the "Origin of Species," full of the fruitage of this new line of study, we find the following:

"The scientific basis for the theory of descent rests in the fact that it alone is able to explain in a simple manner all the mutual relationships of plants to one another, to the animal kingdom, and to the facts of geology and paleontology, their distribution at different times over the surface of the earth, etc.; since it requires no other hypothesis than descent with variation, and the continued struggle for existence which permits those forms only to persist that are endowed with sufficiently useful properties, the others perishing sooner or later. But both these hypotheses are supported by an infinite number of facts. The theory of descent involves only one hypothesis that is not directly demonstrated by facts, namely, that the amount of variation may increase to any given extent in a sufficiently long time. But, since the theory which involves this hypothesis is sufficient to explain the facts of morphology and adaptation, and since these are explained by no other scientific theory, we are justified in making this assumption."

SIXTH ANNUAL REPORT OF THE STATE BOARD OF HEALTH OF MASSACHUSETTS. 379 pages. January, 1875.

THIS report opens with a feeling tribute of respect, from the pen of Dr. Henry I. Bowditch, Chairman of the Massachusetts State Board of Health, to the memory of

Dr. George Derby, its former able Secretary, who died June 20, 1874; and to whose excellent judgment and untiring exertions the usefulness of the Board in past years, and its present high position as an authority in sanitary matters, are largely due.

The subjects of the papers contained in this report are the following:

"Inebriate Asylums or Hospitals," by Henry I. Bowditch, M. D. In this paper the line has been drawn between vicious and morbid drunkenness: yet the former may finally become the latter. The writer suggests a means of dealing, through inebriate asylums, with one of the most troublesome questions of the day. The Board, feeling the importance of the subject, has passed a resolution recommending to the Legislature, as a sanitary measure of the highest importance, the establishment or endowment of one or more inebriate asylums or hospitals.

"The Value of Health to the State," by W. E. Boardman, M. D., of Boston. Whether all disease, or any class of diseases, can be prevented or "stamped out" or not, the experience of all countries has shown that the death-rate may be very sensibly diminished by attention to sanitary laws; and the writer has shown in this article that the State can afford to spend some millions of dollars in saving to itself the immense losses now occasioned by disease and consequent poverty in its citizens.

"On the Transportation of Live-Stock," by J. C. Hoadly, Esq., of Lawrence, member of the Board. This essay will commend itself to all persons interested in cattle-transportation, whether financially or from a desire that the transportation and slaughtering of animals may be attended with the least amount of suffering possible, and be conducted in a way to secure to the community the best meat.

"Our Meat Supply and Public Health," by C. F. Folsom, M. D., Secretary of the Board. In this paper are considered the various diseases, parasitic and others, which affect the quality of butcher's meat considered as an article of food for man. The opinions of experts in reference to other conditions in which animal food is sometimes found, and some facts bearing upon the question of its suitableness for our markets, are also shown. The writer divides meat into three classes: 1. That which is unquestionably of first-rate quality, and from animals perfectly sound and healthy; 2. That which is innutritive or lacking in the qualities which the best meat should possess, and inspection is urged for this on economic grounds; 3. That which is positively harmful or dangerous, and in this case inspection is recommended as being necessary on sanitary grounds; finally, the only safe way with regard to pork is shown to consist in never eating it unless thoroughly cooked.

"Cremation and Burial, an Examination of their Relative Advantages," by J. F. Adams, M. D., of Pittsfield. The writer concludes that there exists no necessity, on sanitary or economic grounds, for any change at present, in our manner of disposing of the dead. He shows that cemeteries, if managed with proper care, may be made to conduce to the welfare of the public by affording parks abounding in luxuriant vegetation. At the same time, there is no real objection to cremation, excepting that which arises from religious feeling or association, and which should be respected, so that individuals should be allowed to choose in what way their own remains are to be disposed of.

Other papers are: "The Brighton Abattoir," in which the daily average amount of meat used by each individual of the six hundred thousand supplied by Boston markets is estimated to be about eleven ounces. The paper gives the regulations of the Butchers' Slaughtering and Melting Association, the Revised Sanitary Regulations of the State Board of Health, an Analysis of Butter made from Suet, and the Acts in regard to establishing Abattoirs; "On the Composition of the Air of the Ground Atmosphere," by Prof. Wm. Ripley Nichols, of Boston; "The Ventilation of Railroad-Cars," by T. W. Fisher, M. D., of Boston, with "Chemical Analyses of the Air in Cars," by Prof. Nichols; "Health of Towns;" and a "Report on the Sanitary Condition of the State Prison at Charlestown," close the volume.

THE LAW OF INHERITANCE, OR THE PHILOSOPHY OF BREEDING. By E. LEWIS STURTEVANT, M. D.

THE two great efforts of the agriculturist should be how to raise the best crops, and

how to beget and perpetuate the best stock. Any thing that incites thought and action in this direction must advance agriculture and lay more deeply and broadly some of the foundations of national wealth. As Dr. Sturtevant's treatise is of this nature, and is eminently philosophical and scientific, it deserves well of all interested in this class of subjects. Its teachings, if generally understood, will lead to intelligent action in a line in which at present too much is left to lucky accidents.

MEMOIRS OF THE ROYAL ASTRONOMICAL SOCIETY. Vol. xl. A Catalogue of 10,300 Multiple and Double Stars, arranged in the Order of Right Ascension by the late Sir J. F. W. HERSCHEL, Bart., and edited by the Rev. R. MAIN, M. A., F. R. S., Radcliffe Observer, and the Rev. C. PRITCHARD, M. A., F. R. S., Savilian Professor of Astronomy in the University of Oxford. London, 1874.

IN 1863 Sir John Herschel completed a descriptive catalogue of all the nebulæ and clusters known up to that time, the greater portion of which had been discovered by his illustrious father, Sir William Herschel, and by himself. This was a most valuable and complete compilation, and, although containing a list of no less than 5,079 nebulæ and clusters, it is singularly free from errors. This, no doubt, was in great part due to the careful and repeated revisions of the work by Sir John himself, and also to the fact that many lists of nebulæ existed with which Sir John's catalogue was constantly compared. No adequate idea of the amount of labor expended upon the preparation of this list can be given here, but a reference to the Introduction of that Catalogue must be made, where a concise account of the various revisions, collations, and comparisons, with the reductions executed (always in duplicate), extends over five quarto pages.

As the complete results of the observations of nebulæ were now accessible to astronomers in a convenient form, Sir John Herschel turned his attention to the formation of an equally complete catalogue of double stars. He proceeded assiduously with this work, and at the time of his death he had gathered data relating to over 10,000 stars, and had arranged these stars in order of right ascension, and had formed a synoptical history of all the known observations of about 4,000 of these.

This "Catalogue," in its imperfect state, was bequeathed to the Royal Astronomical Society, and volume xl. of their "Memoirs" contains the work completed in the form they have decided to give it, and for which the Society, jointly with the editors (who were but their agents), is responsible. So far we have given a sketch of the history of these two "Catalogues," gathered mainly from the respective Introductions. We propose briefly to indicate the shortcomings of the double-star catalogue, and we can do this best by comparing it with its predecessor in which Sir John Herschel's own plans were fully carried out by himself, and which naturally should have served as a model for the execution of the later catalogue. We will extract an entry from each of the two catalogues, and will explain these, so that an idea may be formed of the amount of information which can be had about any object contained in the two lists. The following extracts are made quite at random; the first from the "Catalogue of Nebulæ," the second from the "Catalogue of Double Stars:"

No. 2052; 688; I, 168; ....; $10^h\ 9^m\ 49^s.9$; $+3^s.623$; 1; 47° 53′ 1″.9; +17″.83; 1; p B; v L; R; v g b M; 4.

No. 2052; h 698; ....; $5^h\ 13^m\ 48^s$; 89° 6′; $+3^s.09$; — 4″.02.

The first entry relates to No. 2052 of the catalogued nebulæ, and we learn from it (taking the numbers in their order from left to right) that this nebula is No. 688 of Sir John Herschel's previous catalogue; is No. 168 of Sir William Herschel's Class I.; that no other persons have published any observations of this up to 1863; that its Right Ascension for 1860.0 is $10^h\ 9^m\ 49^s.9$; that the annual precession in Right Ascension for 1880 is $+ 3^s.623$; that the number of observations upon which this place depends is 1; that its North Polar Distance for 1860.0 is 47° 53′ 1″.9; that the precession in North Polar Distance for 1880 is +17″.83; that 1 observation was used to determine its position in North Polar Distance; and that this Nebula is "*p*retty *B*right; very *L*arge; *R*ound; very *g*radually *b*righter in the *M*iddle; and finally, that it has been

observed 4 times by the Herschels." In short, we know something about this Nebula. Interpreting the entry from the "Double Star Catalogue," we find about No. 2052 that it is No. 698 of Sir John's previously published list; that it has been observed by no one else; that its Right Ascension for 1830 is $5^h\ 13^m\ 48^s$; its North Polar Distance is for the same epoch 89° 6′; and that the precessions in Right Ascension and North Polar Distance are for the same epoch $+3^s.09$ and $-4''.02$ respectively.

There is not a word about the relative magnitudes of the component stars of the double star referred to, not a word to show whether it is double, triple, quadruple, or multiple, not a word about the *position*, *angle*, and *distance* of the component stars of the double (if it is a double), and finally, not a word about the *colors* of the components. In short, we know next to nothing about this star. The little we do know is this: 1. Its position in 1830, and we have the means of determining the position with tolerable accuracy at present; and, 2. We know where to look in Sir John's partial "Catalogues," which are scattered through many volumes of the Royal Astronomical Society's "Memoirs," the observations at the Cape of Good Hope, etc., for the information regarding *position*, *distance*, *color*, and *magnitude*, which is precisely what we require, and which is precisely what is omitted from this new "Catalogue." Thus we may estimate its value to be that of an extended index to various double-star observations, with the approximate positions of these stars. After what we have said, it is unnecessary to go further. Any one can see that to the astronomer this "Catalogue" is of but slight value, while to the average double-star observer (who often has not the means of determining accurately star-positions) it is tantalizing and almost useless. When he finds a double star, how is he to know whether it is new or not, except by going over much of the same work that has been done once by the computer of this "Catalogue?" In fine, this book can only be considered to be truly useful when it is accompanied by the "Memoirs" from which the materials were originally drawn. The publication is not creditable to the Royal Astronomical Society, to the memory of its distinguished projector, nor to its able editors. These gentlemen might well have consulted the work of Dr. Anwers on a similar subject, "*William Herschel's Verzeichnissen von Nebelflecken und Sternhaufen, bearbeitet von* Arthur Anwers, 1862," for a model as to the way in which the memory of a great astronomer should be honored, and as to the manner in which alone it is worth while to do astronomical work.

SEVENTH ANNUAL REPORT ON THE NOXIOUS, BENEFICIAL, AND OTHER INSECTS OF MISSOURI. By C. V. RILEY, State Entomologist.

IN this volume (published April 1st) Prof. Riley specially considers six insect-pests, viz., the Colorado potato-beetle, chinch-bug, apple-tree borer, canker-worm, *Phylloxera*, and the Rocky Mountain locust, improperly called grasshopper. Mr. Riley gives the results of his observations and inquiries during the past year on each of these different insects, and, as in all his previous reports, keeps steadily in view the great practical object of his research, namely, the discovery of the best and most effectual means of annihilating these enemies of agriculture. In Missouri the farmers now accept the presence of the Colorado beetle as the necessary concomitant of the culture of the potato; but they do not fear it as once they did, being provided with the means of keeping the pest in check. Prof. Riley has, for years, recommended the use of Paris green in the war of extermination against this beetle, and the farmers of Missouri now very generally employ this substance, and with the best results: in short, it is by far the cheapest and most effectual means of destroying the beetle. "But, then, Paris green is a deadly poison, and therefore its use causes more mischief by far than could ever be done by the Colorado potato-bug." Prof. Riley, however, speaks from experience, and he asserts that there is no danger to be apprehended from the use of Paris green, "except through carelessness and exposure to its direct influence." Millions of bushels of potatoes were last year grown in Missouri, and great quantities of Paris green used in sprinkling the leaves of the growing plants, and yet the author has not heard of a single case of poisoning, save where people had

been careless. After discussing the subject very fully, the author concludes with these words: "I would say to those agriculturists of the East who are in any way alarmed by what has been written on this subject, and who hesitate to use the Paris-green mixture —profit by the experience of your more Western brethren, and do not allow the voracious *Doryphora* to destroy your potatoes, when so simple and cheap a remedy is at hand."

The aggregate loss to Missouri farmers, in 1874, from the chinch-bug, is estimated at $19,000,000. The only measure at present known to be effectual against this pest, when it has spread, is irrigation. On the subject of the grape *Phylloxera*, Prof. Riley is an authority both at home and in Europe. A few facts, of interest to entomologists, in the life-history of this insect, are noted in the present volume. Mr. Riley gives a brief narrative of the researches made in France during the year, with a view to discovering a means of destroying this pest. Dumas's method is as follows: A hole is bored with an auger in the earth, near the foot of the vine, and in it are placed about four ounces of alkaline sulphocarbonate. By decomposition the sulphuret of carbon is formed, which kills the *Phylloxera*, without injuring the vine. We see, from the report of a recent meeting of the French Academy of Sciences, that this method "has been tried with great success in several of the more important vine-growing districts."

The territory in Missouri ravaged by the Rocky Mountain locust in 1866, and again in 1874, is represented in a map, in which is also indicated the direction in which the insects came during the latter year. Last May the Governor of Missouri proclaimed a day of fasting and humiliation as a stratagem in the anti-locust war. Prof. Riley, last year, "prophesied" that the locusts of 1874 would come too late to do much damage. He then asserted, and now asserts, that beyond the extreme western tier of counties Missouri need not dread these invaders. The event has confirmed the accuracy of Prof. Riley's conclusions. The Governor would have done well had he given ear to this truthful prophet, before he uttered his cry of distress.

DETERMINATION AND CLASSIFICATION OF MINERALS. By JAMES C. FOYE, A. M., Professor of Chemistry and Physics, Lawrence University, Wisconsin. Pp. 38. Price 75 cents. Chicago: Jansen, McClurg & Co., 1875.

THE object of this little work, as the author says, is to furnish tables by which the student may, with as few easy tests as possible, determine with precision, and classify, minerals found in the United States, and become familiar with their principal characteristics.

ANNUAL REPORT OF THE BOARD OF SCHOOL COMMISSIONERS OF THE CITY OF MILWAUKEE, for the Year ending August 31, 1874.

NOTHING neater, as respects typography and book-making, can be found in any educational document East. The table of examinations of teachers shows, in the large number of rejections, that honest work is attempted. Superintendent McAllister's scheme for uniform examination of the schools seems to us philosophical.

SYSTEMATIC CATALOGUE OF VERTEBRATA OF THE EOCENE OF NEW MEXICO; collected in 1874. E. D. COPE, A. M.

THIS is a *morceau* of Lieutenant Wheeler's Reports. Of this essay the writer says it completes the determination of the fossil vertebrate species obtained in the Eocene of New Mexico during the field-work of 1874. The total species of mammalia is forty-seven, of which this essay "introduces twenty-four for the first time," besides some reptilia and fishes.

PUBLICATIONS RECEIVED.

The Keys of the Creeds. Pp. 200. New York: Putnams. Price, $1.25.

The Miracle of To-Day. By Charles B. Warring. Pp. 292. New York: Schermerhorn & Co. Price, $2.00.

Heat, Light, Electricity, and Magnetism. By Charles Skelton, M. D. Pp. 75. Trenton, N. J.: Naar, Day & Naar.

Curious Anomaly in the History of Larvæ of Acronycta Oblinita. By Thomas G. Gentry. Pp. 30.

Mysteries of Hierarchy. Pp. 14.

Climatology of Florida. By A. S. Baldwin, M. D. Pp. 39. Charleston, S. C.: Walker, Evans & Cogswell.

Secular Sermons, No. 1. By John McIntosh. Pp. 20. Rochester: C. H. Stump.

Language, its Nature and Functions. By Rev. J. H. Pettingell, M. A. Pp. 26. Washington: Gibson Bros.

Report of the Managers of the State Lunatic Asylum, Utica, for the Year 1874. Albany: Weed, Parsons & Co.

Management of the Insane. By Henry Howard, M. D. Pp. 14. St. Johns, N. B.: *News* Print.

A Protest against the High-Pressure System of Education. Same Author. Pp. 24.

Philosophy of Dairy Manufactures. By F. X. Willard, M. A., of Herkimer Co., N. Y. Pp. 29.

The Aërial World (Hartwig). Appletons.

Problems of Life and Mind (Lewes). Osgood.

What Young People should know (Wilder). Estes & Lauriat.

Storms: their Nature, Classification, and Laws (Blasius). Philadelphia: Porter & Coates.

Certain Harmonies of the Solar System (Alexander).

Lists of Elevations (Gannett).

Fishes of the East Coast of North America (Gill).

Eighth Annual Report of the Trustees of the Peabody Museum.

Meteorological Observations (Chittenden).

MISCELLANY.

Notices of Recent Earthquakes.—The *American Journal of Science* for May gives a summary of earthquakes for the year 1874, prepared by Prof. C. G. Rockwood, Jr., of Rutgers College, New Jersey. They are reported from nearly all quarters of the globe, forty-three in number. Two of these were disastrous, but in most cases the shocks appear to have been light.

Fourteen shocks are reported as having occurred in the United States. The most important of these took place in North Carolina, in Bald and Stone Mountains. The shocks continued at intervals from February 10th to April 17th, with explosive and rumbling noises. The most severe shock was felt February 22d. On one occasion the sound of the shock resembled that made by blasting in a deep quarry, first explosive, then reverberating.

The shock which occurred in the vicinity of New York City, December 10, 1874, is noticed. It extended as far as Peekskill on the north, and Norwalk, Connecticut, on the east. The shock was most severe in the neighborhood of Tarrytown and Nyack, but did no damage anywhere.

The most disastrous earthquakes occurred at and near Harpoot Mission, Eastern Turkey, destroying the houses of Haloosi, a considerable town near that place, and at Volcan del Fuego in Guatemala. This earthquake destroyed the town of Duenos. From a small mountain near the base of the Volcan del Fuego there issued an eruption of cold compact mud.

Testing Iron and Steel.—We have received the programme of organization of a Board appointed by the President, in accordance with the provisions of an act of Congress, making "appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1876, and for other purposes."

The instructions of the Board are, to determine by actual tests the strength and value of all kinds of iron, steel, and other metals, which may be submitted to it, or by it procured, and to prepare tables which will exhibit the strength and value of said materials for constructive purposes. The members of this Board are Lieutenant-Colonel T. T. S. Laidley, U. S. A., President, Commander L. A. Beardslee, U. S. N., Lieutenant-Colonel Q. A. Gillmore, U. S. A., Chief-Engineer David Smith, U. S. N., W. Sooy Smith, C. E., A. L. Holley, C. E., and R. H. Thurston, C. E., Secretary.

The Board has organized into standing committees to conduct special experiments and investigations, during the delay in preparing the testing machinery for the regular work of the Board, and afterward, as leisure

will permit. These investigations are expected to be made with critical and scientific accuracy, and will consist in the minute analysis of a somewhat limited number of specimens, and the precise determination of mechanical and physical properties, with a view to the detection and enunciation of the laws connecting them with the phenomena of resistance to flexure, distortion, and rupture.

The Board will be prepared to enter upon a more general investigation, testing such specimens as may be forwarded to the President of the Board, or such as it may be determined to purchase in open market, immediately upon the completion of the apparatus ordered, at which time circulars will be published giving detailed instructions relative to the preparation of specimens for test, and stating minutely the information which will be demanded previous to their acceptance.

The following is a list of the subjects to be investigated by the standing committees, as given in the circular issued by the Board: Abrasion and Wear; Armor-Plates; Chemical Research; Chains and Wire Ropes; Corrosion of Metals; Effects of Temperature; Girders and Columns; Iron, Malleable; Iron, Cast; Metallic Alloys; Orthogonal Simultaneous Strains; Physical Phenomena; Reheating and Rerolling; Steels produced by Modern Processes; Steel for Tools."

Insulation of Lightning-Rods.—We take from the *Journal of the Telegraph* a few valuable observations on the subject of lightning-rods. The insulation of lightning-rods, says the *Journal*, is a grave error, because the insulators to some extent arrest the flow of currents of rarefied electricity, which it is the true function of the lightning-rod to facilitate. On the other hand, the insulator amounts to nothing as a barrier against a discharge of lightning, which can either pass through it or leap the short distance between the rod and the building. The prejudice in favor of insulators arises from a misapprehension. Strictly speaking, there are no non-conductors; but that term is applied to substances which conduct very imperfectly and are subjected to violent disruptive effects when a shock of electricity passes through them. To prevent a discharge from leaving the rod and passing through the building, something more must be done than to attempt to keep it out by erecting such flimsy and insignificant barriers as insulators. The rod must be arranged so as to present points for the reception and discharge of electricity at the extremities of the building, both above and below, and the different terminations in the ground must be connected by rods lying across the roof, so that lightning can be provided with a path in an horizontal direction, which, being continuous, will be preferred to any series of detached masses of conducting matter contained within the building.

Action of Absinthe and Alcohol.—In an essay which received a prize from the French Academy of Sciences last December, Dr. Magnan states as follows the comparative action of absinthe and of alcohol: Whether injected into the stomach, pulmonary passages, cellular tissue, or vascular system, these two agents produce different effects. Essence of absinthe, in weak doses, causes vertigo and sudden contractions in the muscles of the anterior portion of the body; in strong doses, epileptic attacks and mental disorder. The well-known effects of alcohol are muscular debility, staggering, relaxation of the limbs, and finally comatose sleep, without any epileptic symptoms. Injected simultaneously, alcohol and absinthe, instead of neutralizing, intensify one another, and the absinthine phenomena are in part masked under the alcoholic. The substances used in the manufacture of the *liqueur absinthe*, viz., the essences of anise-seed, angelica, sweet-flag, marjoram, fennel, mint, possess no toxic action. Hence all the injurious effects of the liqueur are due purely to the wormwood. Epileptiform symptoms never follow from the use of alcohol, and they are characteristic of absinthe.

Fish-Life and the Pollution of Rivers.—The injurious effects on fish of the pollution of rivers with the refuse of gas-works have been very thoroughly investigated by Prof. A. Wagner, of Munich, and from his report on the subject we take the following account of some of his experiments. His method

was to put small fishes into vessels containing well-water, different amounts of gas-water being added. In water to which one per cent. of gas-water was added, the fish became at once very restless, tried to jump out, turned on their backs after they had been in the polluted water one minute, and were dead after the lapse of six minutes. With one-half per cent. gas-refuse, the fish became at once restless, floated on their backs after five minutes, and died after thirty minutes. With one-quarter per cent. gas-refuse they became restless after some time, floated on their backs in one hour, and were dead after ninety minutes. With one-tenth per cent. refuse, they at first remained quiet; one of them showed no change after three hours and a half, but died after the lapse of six hours; no change was observed in another, a small pike, after seven hours, but it was dead the next morning.

Lightning in an Electric Clock.—A writer in *Poggendorff's Annalen* describes some curious effects of lightning on the wires of an electric clock on a steeple in Basle. The wire, which was sheathed in gutta-percha and cotton, was torn away and lay about in pieces from four to forty inches in length. These pieces at first sight presented nothing worthy of note, but they were found to have quite lost their stiffness, and further examination showed that they consisted only of the sheath; the copper was entirely gone. The interior of the sheath was smooth, and the sheath itself was whole except in a few places at variable intervals, where there were minute ruptures. These were evidently the holes at which the copper had escaped—as some remains of the metal sticking in them showed. These remains distinctly proved, too, that the copper had been driven out, for the most part, in a molten state. This melting of the wire must have been instantaneous, for the molten copper was expelled before its heat could act upon the sheath. Another striking fact is that, in a portion of the wire which was inclosed for protection in a lead pipe, the copper was quite unchanged, while the gutta-percha had been fused in several places. Here the lead acted by retarding the electric current, and thus the wire had time to give up its heat to the sheath.

Influence of Camphor on Plant-Growth.—Vogel, of Munich, who has studied very closely the action of camphor on plants, says that it acts like a kind of stimulant on vegetative processes, which it accelerates and intensifies. In one of his experiments he placed a branch of flowering syringa in ordinary water, and another branch in camphor-water; in twelve hours the one drooped, while the other stood upright and even developed some of its buds. This branch did not begin to wither till after the third day. Another experiment consisted in placing in camphor-water a flowering branch of syringa which was nearly dead. In this instance the plant revived, living for some time. Similar results were obtained from experiments with seeds. Oil of turpentine was found to act like camphor. It accelerated the germinative process in seeds, but it exerted an injurious action on the after-development of the plants. Vogel remarks, in conclusion, that the process of germinating, receiving of oxygen, and giving out of carbonic acid, is identical with animal respiration. From the agreement of the vegetable processes in the early period of germination with the animal processes, it would seem to follow that stimulants would have similar effects in the two cases.

A New Deep-Sea Thermometer. — Dr. Neumayer recently exhibited to the Berlin Geographical Society a new apparatus for the determination of the temperature and of the currents at great depths in the ocean. The apparatus consists of an hermetically-sealed copper box, with an external appendage resembling a rudder. In the interior are a mercury thermometer and a compass, each inclosed in a glass receptacle, in which are admitted traces of nitrogen gas. A small electric battery completes the apparatus. When it is allowed to descend attached to a sounding-line, the action of the current on the rudder causes the apparatus to take an horizontal direction, thus indicating the set of the flow by the relative positions of compass-needle and rudder, while the thermometer indicates the temperature. To fix these indications, a piece of photographic paper is suitably disposed near the glass cases containing the instruments. Then at

the proper time a current of electricity is established through the gas in the receptacles, causing an intense violet light, capable of acting chemically on the paper for a sufficient length of time to photograph the shadows of the compass-needle and the mercury column. Within three minutes the operation is complete, and then the apparatus is hoisted and the paper removed.

Absorption of Water by Growing Grain.—M. Marie-Davy has been making some exact measurements of the quantity of water consumed by grain during its growth. He found that corn in pots, filled with earth and watered daily, consumed 1,796 grammes of water daily to produce one gramme of grain. According to this, a yield of thirty hectolitres (eighty bushels) of corn per hectare (two-fifths of an acre) would take up a quantity of water which, along with the water evaporated, forms a greater total than the amount of the average rainfall of Paris. Thus the yield of the land is limited by the amount of water supplied to the fields. M. Marie-Davy, however, points out that the quantity of water necessary to produce a given harvest is by no means absolute, but depends on the amount of useful mineral matters with which the water can be charged. To a certain extent water supplements manure, and *vice versa*. Some manures may effect a very considerable economy in the mass of water consumed.

Vegetation as a Disinfectant.—In a paper advocating the utilization of sewage for agricultural purposes, Dr. Alfred Carpenter says that, if a certain weight of rye-grass seed be sown in wet sand, without allowing the contact of any water which contains nitrogenous matter, the plants will grow to a certain size, that is, until they have used up all the matter contained in the seed, and then growth is, to a great extent, arrested. This has been shown experimentally by growing rye-grass under glass. All growth has been arrested for want of nourishment. On adding to the water solutions of fresh organic matter (meat-juice), the plant has at once begun to grow, and in a few days has doubled its size, while a test set of plants to which such organic matter has not been added has remained stationary. Another basin and glass cover with sand not containing rye-grass, but to which organic matter had been added, became putrid in a few days, but no such putridity appeared when the rye-grass was growing. A fourth case had put into it an amount of nitrate of ammonia corresponding to the amount estimated to be contained in the meat-juices which were used in the first case; but here the growth of the plant was by no means so luxuriant as when the living nitrogenous matter was added: although a fresh start was made, the plant soon dwindled away and died. Thus it appears that living vegetation acts as a powerful disinfectant, assimilating directly the nitrogenous principles of organic substances.

Nutritive Value of Cocoa.—The nutritive constituents of cocoa correspond very closely with those of beef, and largely exceed those of milk and wheaten flour: hence the importance of this substance as an article of food. In this respect it differs widely from tea and coffee, which are, perhaps, rather condiments and stimulants than foods, or flesh-formers. The following table, drawn up by Mr. John Holm, of the Edinburgh Chemical Society, shows the position of cocoa as compared with three other well-known articles of food:

ARTICLES.	Cocoa.	Milk.	Meat (Beef).	Wheaten Flour.
Fat	50.0	3.5	2.87	1.2
Azotized substances.	20.0	4.0	20.75	14.6
Starch	7.0	...	...	59.7
Gum	6.0	...	...	...
Sugar	....	4.3	.....	7.2
Water	5.0	87.5	67.80	13.2
Salts	4.0	0.7	5.60	1.6
Woody fibre	4.0	....	.....	....
Cellulose	....	....	.....	1.7
Coloring-matter	2.0	....	.....	....
Ash	....	...	1.60	0.8
Extractive matters	....	....	1.38	....
Theobromine	2.0	....	....	....
Parts	100.0	100.0	100.00	100.0

"Thus," observes Mr. Holm, "although one-half of the weight of cocoa consists of cocoa-butter, it still presents 20 per cent. of albuminoid material, as against 4 per cent. in milk, 20.75 in beef, and 14.6 in wheat. In addition, it contains starch, which is present neither in milk nor beef, but in smaller proportion than in wheat." The value of cocoa as a food is thus apparent, and fully justifies the high eulogiums which have been passed upon it.

Statistics of Suicide in Prussia.—The number of suicides occurring in the kingdom of Prussia during the four years preceding 1873 is given as follows in the official journal of the Statistical Bureau:

SUICIDES.	1869.	1870.	1871.	1872.
Males	2,570	2,334	2,183	2,363
Females	616	629	540	587
Total	3,186	2,963	2,723	2,950

From this it would appear that either the female sex is less exposed to the temptation of suicide, or resists that temptation better than the male. The table shows that the frequency of suicide increases with age. This is true with regard to the whole number of suicides, not with regard to those of each sex taken separately. Thus suicide is most frequent among males between the ages of ten and fifteen, and again between fifty and sixty, while among females it is most frequent between fifteen and twenty, and again after seventy. Of suicides, married persons constitute 452 per 1,000, unmarried, 339 per 1,000, and the remainder is made up of widows, widowers, divorced persons, etc. Mental disease is by far the most frequent occasion of suicide. Religious belief does not appear to have any marked influence. On the other hand, the influence of various avocations is very evident. The favorite modes of suicide are, in both sexes, hanging and drowning—the latter more frequent in the case of females; then by fire-arms on the part of the males, by poison on the part of the females.

Defects of the Human Eye.—The human eye, because it is practically achromatic, has been supposed to be absolutely so. But it is not difficult to show that the organ is not faultless in this respect. The subject was recently discussed in a lecture by Prof. H. McLeod, at the London Physical Society, and the lecturer cited many facts to show that the eye is not achromatic. Thus to short-sighted persons the moon appears to have a blue fringe. In using the spectroscope, the red and blue ends of the spectrum cannot be seen with equal distinctness without adjusting the focussing glass. A black patch of paper on a blue ground appears to have a fringed edge if viewed from even a short distance; while a black patch on a red ground, when observed under similar conditions, has a perfectly distinct margin. It is interesting to note that Wollaston considered that the colored bands of the spectrum were really divided by the black (Fraunhofer) lines, and his statement, that the red end of the spectrum does not appear to have a boundary-line "because the eye is not competent to converge the red rays properly," shows that he had very nearly, if not quite, discovered the achromatic defects of the eye. An experiment was exhibited by Prof. McLeod to show the relative distinctness of a dark line on grounds of various colors. A wire was so arranged that its shadow traversed the entire length of the spectrum, which was thrown on a screen by an electric lamp. Viewed from a short distance, the edges of the shadow appeared to be sharp at the red end, but gradually became less distinct, until at the blue end nothing but a blurred line remained.

Infrequency of Pulse.—A case of extraordinary infrequency of pulse was recently mentioned by Mr. Pugin Thornton, at a meeting of the Clinical Society of London. The subject was a woman, twenty-nine years of age, thin and anæmic, and suffering from severe inflammation of the larynx, for which the operation of tracheotomy was performed. Just before the operation her pulse was 40, and after it she had an epileptiform attack. She was discharged from the hospital much improved, but was readmitted soon afterward. Her pulse was then found to be beating only at the rate of 16 per minute, the pulsations being strong. The frequency increased slowly for a month, when it was 20, and soon afterward it was again 40. This was some two years ago. Her pulse is now 48, and the patient has grown stout. Normally, the number of pulsations per minute differs at different periods of life: at birth, it is about 135; at the age of seven, from 80 to 85; in adults, 70 to 75; in old age, from 50 to 65. In females, the pulse is quicker than in males.

Ornamentation of Copper and Bronze.—A new mode of ornamenting bronze or copper work is described as follows: After the object has received the desired form, the

drawings are made with water-colors, the body of which is white-lead. Those portions of the surface which are not painted are covered with varnish. The article is then placed in dilute nitric acid, whereby the paint is dissolved, and the surface of the metal is etched to a certain depth. The article is then washed with water, and immediately placed in a silver or gold bath, and a layer of the precious metal deposited by electricity on the exposed portions. When the latter operation is finished, the varnish is removed, and the whole surface ground or polished, so that the ornamented portion is just even with the rest of the surface. A specially fine effect is obtained by producing a black bronze of sulphuret of copper on portions of the surface between the silver ornaments. A copper vase then has three colors, black and white drawings on a red-brown ground of suboxide of copper.

Ancestors of the Esquimaux.—Charles E. DeRance, in one of his papers on "Arctic Geology," points out some of the many striking resemblances between the modern Esquimaux and the paleolithic man of Southern France. These two peoples, separated so widely in time and space, were alike in their artistic feelings and methods of incising, on tusks, antlers, and bones, representations of familiar objects; alike also in their habit of splitting bones for marrow, and accumulating them around their dwellings; in their disregard for the sepulchre of their dead; in their preparation of skins for clothing, and in the pattern of the needles used in sewing them together; alike also in their feeding on the musk-sheep and the reindeer, and in countless other characteristics. It is wellnigh impossible to resist Prof. Dawkins's conclusion that the Esquimaux is the descendant of paleolithic man, who retreated northward with the arctic fauna with which he lived in Europe.

Antidote to Atropia.—Dr. G. Rückert has made the interesting discovery that the poisonous alkaloid muscarin (extracted by alcohol from the mushroom *Amanita muscaria*) is a perfect antidote to atropia, and *vice versa*. The pupil of the eye, enlarged by atropia, is contracted by muscarin. So, too, the depression of temperature induced by subcutaneous injection of muscarin is counteracted by the other alkaloid similarly injected. The heart of a frog, whose action had ceased from thirty to sixty minutes under the influence of muscarin, had its activity restored by the exhibition of atropia. The relation of quinine to the specific poison of intermittent fevers is probably analogous to that between these two alkaloids.

NOTES.

CORRECTION.—Prof. Henry Wurtz corrects an error in the theory of A. McDougall, of the Manchester Literary and Philosophical Society, on the possible mode of formation of graphite, as given in our Notes for last month. As he points out, the carbon which collects in gas-retorts does not give the reactions of graphite with a mixture of chlorate of potassium and nitric acid; it is not converted into graphitic acid; therefore it is not graphite at all, and of course its formation cannot explain the formation of that mineral. It has even been shown by Berthelot that gas-retort carbon contains hydrogen, being in fact a highly-condensed hydro-carbon, or mixture of hydro-carbons.

THE Aniline Manufacturing Company, of Berlin, are now producing aniline colors by Coupier's process, in which no arsenic acid is employed. Being free from arsenic, these dyes are not only fitted for coloring sweetmeats, liqueurs, syrups, and pharmaceutical preparations, but may be used in many other industrial purposes where poisonous colors would be more or less dangerous, as in the staining of paper, paper-hangings, toys, etc.

A FLAME burning in condensed air gradually increases in brilliancy with the compression, till at last it becomes as brilliant as the flame of phosphorus in oxygen. But, if the pressure be still further increased, the process of combustion is retarded, and the flame becomes smoky. From this it would appear that the temperature of combustion increases with the pressure up to the point of dissociation of the hydro-carbon gases of the candle. Hence the conclusion that it is an error to estimate the temperature of the sun at several millions of degrees. Sainte-Claire Deville holds that 2,000° C. is the highest possible temperature.

SCHWEINFURTH, the distinguished African traveler, has been appointed by the Khédive Director-General of all the large collections, museums, and other scientific institutions, of Cairo.

THE length of time needed for reaction in sensation has been made a subject of investigation by two German physiologists, Vintschgau and Hongschmied, with the following results: In the case of a person whose sense of taste was highly developed, the reaction-time was, for common salt, 0.159 second; for sugar, 0.1639 second; for acid, 0.1676 second; and for quinine, 0.2351 second. With a person whose taste was less acute the reaction-times were 0.595 second for salt, 0.752 second for sugar, and 0.993 second for quinine. It will be seen that in both instances for the bitter taste of quinine the reaction-time was considerably longer than for the others.

THE most noteworthy circumstance connected with Captain Boyton's feat of crossing the English Channel is, not so much his having been kept afloat for so many hours, but that his body temperature was not lowered appreciably. His water-proof dress prevents the loss of animal heat, and hence, after being in the water for fifteen hours, Captain Boyton was almost as fresh and vigorous on reaching Boulogne as when he started from Dover.

AN apothecary and self-styled surgeon in Liverpool, named Heap, was recently hanged for the crime of attempting to procure abortion on a young woman, and so causing her death. The jury recommended the culprit to mercy, but the authorities very commendably refused to interfere with the process of the law.

IN view of the prohibitory duties imposed by the United States upon imported agricultural machinery, the British Association of Agricultural Engineers recommends manufacturers to hold aloof from the Philadelphia Exhibition. The imposition of prohibitory duties is declared to be out of harmony with the objects of international exhibitions. This advice will be adopted almost unanimously in England.

A SCIENTIFIC ASSOCIATION has been organized in Peoria, Ill., with Dr. W. H. Chapman as president. Arrangements have been completed by the Association for a "Summer School" for the study of botany and zoölogy, the term to extend over four weeks, commencing on July 5th. The instructors will be Profs. Burt G. Wilder and J. H. Comstock, of Cornell University, and Prof. Alphonso Wood. The tuition for the term will be fifteen dollars.

THE meeting of the British Association for the Advancement of Science takes place this year at Bristol, commencing Wednesday, August 25th. The President of the Association for the present year is Sir John Hawkshaw, C. E., Fellow of the Royal Society.

A DONATION of $25,000 for library purposes has been made to the Philadelphia Academy of Natural Sciences. The library of the Academy already contains 20,000 scientific works, but is in many respects incomplete. It is believed that with the means now at the disposal of the Academy the library can be made equal to any scientific library in the world.

DIED, March 20th, DANIEL HANBURY, F. R. S., F. L. S., member of the British Pharmaceutical Society. Deceased had attained distinction by his original investigations into the nature and history of drugs, and of the plants from which they are obtained. Just before his death appeared "Pharmacographia: a History of the Principal Drugs of Vegetable Origin met with in Great Britain and British India." Of this work Hanbury was joint author with Prof. Fluckiger, of Strasburg.

THE committee of the Bremen Polar Expedition propose that their vessels shall coast along the eastern shore of Greenland, while the English expedition proceeds up Smith's Sound. If this arrangement is carried out, possibly these two expeditions may meet at the pole, or at all events at the northernmost portion of Greenland.

THE Anderson School of Natural History, at Penikese Island, will not be opened this summer. A card from Prof. A. Agassiz states that "the applications for this summer's session have been so much reduced by the attempt to make the school partially self-supporting, that the trustees are forced, in order to save the institution from debt, to close it for the coming season. Since no assistance is to be expected from State Boards of Education, it becomes evident that the school must be carried on either by the help of the teachers for whose advantage it is intended, or by endowment. This interruption, which it is hoped may be only temporary, arises neither from lack of enthusiasm in the pupils of Penikese, nor from any want of generous interest in the naturalists who have thus far given their services to aid the enterprise."

THE French Geographical Society has awarded a gold medal to the family of the late Captain Hall, in recognition of the distinguished services rendered to geographical science by that intrepid explorer.

THE *Gardener's Chronicle* states, on the authority of the market-gardeners around London, that the spring just passed was the most backward known in that locality for many years.

DR. J. BELL PETTIGREW has been awarded the Goddard prize of the French Academy of Sciences for his original anatomical and physiological memoirs.

THE *Sanitarian* publishes a table showing the death-rate of various cities in the United States for the month of March, from which it appears that the highest death-rate (Nashville) was 37.69 per thousand per annum, and the lowest (St. Louis) 13.37. Other cities showed the following death-rates: New York, 30.25; Philadelphia, 26.30; Brooklyn, 23.54; Chicago, 15.73; Boston, 22.67; New Orleans, 26.72; Washington, 33.36; Richmond, 26.40; Charleston, 34.50; New Haven, 19.80.

A PARTY of Englishmen, Drs. Freeland and Nicholls, Captain Gardner, and Mr. Watt, while exploring the steep and forest-covered mountain behind the town of Rosseau, in the republic of Dominica, came upon a boiling lake about 2,500 feet above the sea-level, and two miles in circumference. When the wind cleared away for a moment the clouds of sulphurous steam with which the lake was covered, a mound of water was seen ten feet higher than the general level, and caused by ebullition. The margin of the lake consists of beds of sulphur; at the outlet is a waterfall of great height.

THE twenty-fourth meeting of the American Association for the Advancement of Science will be held at Detroit, Mich., commencing on Wednesday, August 11th. The Permanent Secretary calls special attention to the meeting of the Entomological Club. It is proposed to form a subsection of Anthropology at the coming meeting of the Association. Officers of this year's meeting: President, Prof. J. E. Hilgard; Vice-President, Section A, Prof. H. A. Newton; Section B, Prof. J. W. Dawson; chairman, Chemical Subsection, Prof. S. W. Johnson.

M. LE VERRIER, Director of the Paris Observatory, transmits twice daily to the principal ports of France forecasts of the probable weather for the ensuing twelve hours. The present system does not include signals to give warning of storms. The telegrams are posted up in some public place.

IT is suggested to form an artificial isthmus between France and England, leaving a narrow space in the centre for the passage of ships. The expense would not be much greater than in boring a tunnel, and the advantages in some respects greater.

A NEWSPAPER paragraph gives this instance of community of disease in man and animals. A large Newfoundland dog, belonging to a Mr. Wallace, of Upton, Mass., contracted measles from the children of a Mr. Walker, and died of the disease. The dog exhibited all the symptoms of measles as seen in human beings, and under medical treatment was convalescing, when he ran out in the snow, was chilled, and died.

A CLUB has lately been formed in this country for the circulation among its members, by way of the United States mails, of microscopic objects. Applications for membership should be made to the secretary of the club, Rev. A. B. Hervey, 10 North Second Street, Troy, N. Y. Those only are eligible as members who are accustomed to work with the microscope, and who can contribute to the usefulness of the club by sending good objects for examination.

AT the Louisville meeting of the American Medical Association, S. D. Gross, M. D., of Philadelphia, avowed himself an advocate of bloodletting for many diseases, especially those of an inflammatory character. He predicted that phlebotomy would again come to be recognized as a therapeutic agent, but that it would not be practised indiscriminately.

PETTENKOFER has shown that a cubic foot of soil contains one-third of a cubic foot of air. Now, according to Boussingault, the amount of carbonic acid in this air is much more than that in the atmosphere. He found that in a field recently manured it amounted to 221 parts in 10,000 of air; in a vineyard, 96; forest-land, 86; loamy subsoil, 82; sandy subsoil, 24; garden-soil, 36.

THE title of the society known as the New York Lyceum of Natural History has been changed. It will henceforward be known as the New York Academy of Sciences.

A CORRESPONDENT of the Department of Agriculture writes that a decoction of tansy is always effectual in killing bots. He gives the tansy in the morning to a horse infested with bots, and in the evening a dose of salts; the bots die, and pass out with the excretions.

BLACK silks are very commonly "weighted" with foreign substances to the amount of 100, 200, and 300 per cent. This increase in weight is caused by treatment with salts of iron and astringents, salts of tin and cyanides. In fact, what is sold as silk is a mere agglomeration of heterogeneous matters, held temporarily together by a small portion of silk.

IT is stated by Paul Perny, formerly a pro-vicar apostolic in China, that the Emperor Kien-Lung, who lived upward of a century ago, drew up the plan of a general encyclopædia of human knowledge, the publication of which still goes on. Nearly 100,000 volumes of this work have appeared, and there remain 60,000 volumes to be published! M. Perny further states that the Chinese have encyclopædias of more than 300 volumes on agriculture, horticulture, pisciculture, etc.

HORSESHOE CAÑON.